```
          -. Dweb  =  Cw - tw   =    0.93 m.
          -. DTRw  =  Dweb/tf   =   24.51  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.122 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  41998.9307 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  4.9929e+007 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.592 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.6374e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  4.9929e+007 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =        1188.82 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       41984.15 kN.
          -. phiPn =  phi*Pn  =      37785.73 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2045.80
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           37785.73

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 9191.68 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 9191.68 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{522.85}{9191.68} = 0.057 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 11698.59 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 11698.59 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 11698.59 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{2575.37}{11698.59} = 0.220 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.027 + [\ 0.057 + 0.220\ ]$$

$$= 0.304 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 15388.40 kN.
-. Vny = C*Vp = 15388.40 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = I)
-. Applied shear force : Vuy = 243.74 kN.
Vuy 243.74
-. -------- = --------------- = 0.016 < 1.000 ---> O.K.
phiVny 15388.40

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 9461.58 kN.
-. Vnz = C*Vp = 9461.58 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 356.51 kN.
Vuz 356.51
-. -------- = --------------- = 0.038 < 1.000 ---> O.K.
phiVnz 9461.58

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 104010,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   148-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78239e+000,  Lz   = 1.78239e+000,  Lb   = 1.78239e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =148-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2389.83	-397.33	-586.97	-79.95	-77.02
TOTAL	-2389.83	-397.33	-586.97	-79.95	-77.02

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2389.83 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 833912.20 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.73
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1418
Pez = (Area*Fy)/Lambda^2 = 1011373.47 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2389.83	-586.97	-77.02
TOTAL	-2389.83	-586.97	-77.02

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -586.97 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -77.02 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  833912.1953 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2329e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  833912.1953 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.02 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.65 kN.
          -. phiPn =  phi*Pn  =      18108.58 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2389.83
          -. -------  =  ---------------  =          0.13  <  1.000  --->  O.K.
              phiPn           18108.58

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2310.95 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2310.95 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                586.97
           -. --------  =  ---------------  =  0.254  <  1.000  --->  O.K.
               phiMny             2310.95

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       2490.69 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       2490.69 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       2490.69 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                 77.02
           -. --------  =  ---------------  =  0.031  <  1.000  --->  O.K.
               phiMnz             2490.69

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.066 + [  0.254  +  0.031 ]
                      =  0.351  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 18.47 kN.

$$\frac{Vuy}{phiVny} = \frac{18.47}{6856.22} = 0.003 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 348.19 kN.

$$\frac{Vuz}{phiVnz} = \frac{348.19}{6094.42} = 0.057 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104011,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04474e+000,  Lz   = 1.04474e+000,  Lb   = 1.04474e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


================================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1737.54	-513.45	-473.80	-179.53	-181.51
TOTAL	-1737.54	-513.45	-473.80	-179.53	-181.51

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1737.54 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848289.38 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686558.32 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1737.54	-473.80	-181.51
TOTAL	-1737.54	-473.80	-181.51

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -473.80 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -181.51 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 2848289.3804 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8655e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848289.3804 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.09 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.94 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1737.54
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               473.80
           -. --------  =  ---------------  =  0.175  <  1.000  --->  O.K.
               phiMny            2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               181.51
           -. --------  =  ---------------  =  0.055  <  1.000  --->  O.K.
               phiMnz            3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.043 + [  0.175  +  0.055 ]
                      =  0.272  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 23.11 kN.

$$\frac{Vuy}{phiVny} = \frac{23.11}{8273.17} = 0.003 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 444.03 kN.

$$\frac{Vuz}{phiVnz} = \frac{444.03}{6094.42} = 0.073 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 104020,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   148-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78168e+000,  Lz   = 1.78168e+000,  Lb   = 1.78168e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =148-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2399.82	-392.00	-592.52	-53.91	-58.56
TOTAL	-2399.82	-392.00	-592.52	-53.91	-58.56

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2399.82 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834573.41 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1012175.40 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2399.82	-592.52	-58.56
TOTAL	-2399.82	-592.52	-58.56

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -592.52 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -58.56 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  834573.4114 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2339e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834573.4114 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.06 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.81 kN.
          -. phiPn =  phi*Pn  =      18108.73 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2399.82
          -. -------  =  ---------------  =          0.13  <  1.000  --->  O.K.
              phiPn           18108.73

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{592.52}{2310.95} = 0.256 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2490.70 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2490.70 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2490.70 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{58.56}{2490.70} = 0.024 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.066 + [\ 0.256 + 0.024\ ]$$

$$= 0.346 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 15.46 kN.

$$\frac{Vuy}{phiVny} = \frac{15.46}{6856.22} = 0.002 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 336.09 kN.

$$\frac{Vuz}{phiVnz} = \frac{336.09}{6094.42} = 0.055 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104021,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04474e+000,  Lz   = 1.04474e+000,  Lb   = 1.04474e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1799.88	-518.27	-488.28	-165.76	-178.32
TOTAL	-1799.88	-518.27	-488.28	-165.76	-178.32

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1799.88 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848289.38 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686558.32 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1799.88	-488.28	-178.32
TOTAL	-1799.88	-488.28	-178.32

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      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =     -488.28 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =     -178.32 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AASHTO-LRFD12 Specification 6.9.3 ]
           -. Kl/r  =     6.8  <   120.0  --->  O.K.

      ------------------------------------------------------------------------
      [*]  Calculate Qa about y-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  Cw - tw   =    0.47 m.
           -. DTRf  =  Dflg/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
           -. Dweb  =  H-tf1-tf2 =    0.32 m.
           -. DTRw  =  Dweb/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa1 =  A_eff/Area  =   1.000  (about y-axis).

      ------------------------------------------------------------------------
      [*]  Calculate Qa about z-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  H-tf1-tf2 =    0.32 m.
           -. DTRf  =  Dflg/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
```

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848289.3804 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8655e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848289.3804 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.09 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.94 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1799.88
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{488.28}{2713.75} = 0.180 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{178.32}{3288.12} = 0.054 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.044 + [\ 0.180 + 0.054\ ]$$

$$= 0.278 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 19.06 kN.

$$\frac{Vuy}{phiVny} = \frac{19.06}{8273.17} = 0.002 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 447.50 kN.

$$\frac{Vuz}{phiVnz} = \frac{447.50}{6094.42} = 0.073 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 104030,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    73
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Vert_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.621,  Flg Width   =      0.621,  Web Center  =      0.583
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001
        <Pos I>.
         Area = 8.88340e-002,  Asy  = 4.73202e-002,  Asz  = 4.73202e-002
         Ybar = 3.10500e-001,  Zbar = 3.10500e-001,  Qyb  = 1.27596e-001,  Qzb  = 1.27596e-001
         Syy  = 1.62707e-002,  Szz  = 1.62707e-002,  Zyy  = 1.94456e-002,  Zzz  = 1.94456e-002
         Iyy  = 5.05205e-003,  Izz  = 5.05205e-003,  Iyz  = 0.00000e+000
         ry   = 2.38476e-001,  rz   = 2.38476e-001
        <Pos J>.
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.27800e+000,  Lz   = 2.27800e+000,  Lb   = 2.27800e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-207.57	-467.36	-1211.74	-502.78	-94.89
TOTAL	-207.57	-467.36	-1211.74	-502.78	-94.89

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 207.57 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.49
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1783
Pey = (Area*Fy)/Lambda^2 = 680798.35 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 13.49
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1783
Pez = (Area*Fy)/Lambda^2 = 680798.35 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-207.57	-1211.74	-94.89
TOTAL	-207.57	-1211.74	-94.89

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -1211.74 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -94.89 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 13.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.37 m.
-. DTRw = Dweb/tw = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.063 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.37 m.
-. DTRf = Dflg/tw = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.063 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  21640.4298 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  680798.3498 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.278 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.6673e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  680798.3498 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         31.46 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       21354.42 kN.
          -. phiPn =  phi*Pn  =      19218.98 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              207.57
          -. -------  =  ---------------  =          0.01  <  1.000  --->  O.K.
              phiPn           19218.98

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2738.15 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2738.15 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{1211.74}{2738.15} = 0.443 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2738.15 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2738.15 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2738.15 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{94.89}{2738.15} = 0.035 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.005 + [\ 0.443 + 0.035\ ]$$

$$= 0.483 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 475.86 kN.

$$\text{Vuy} / \text{phiVny} = 475.86 / 6856.22 = 0.069 < 1.000 \quad \text{---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6856.22 kN.
-. Vnz = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 326.78 kN.

$$\text{Vuz} / \text{phiVnz} = 326.78 / 6856.22 = 0.048 < 1.000 \quad \text{---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 105001,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =    12
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-1.0_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.825,  Flg Width   =      0.825,  Web Center  =      0.787
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.19924e-001,  Asy  = 6.28650e-002,  Asz  = 6.28650e-002
         Ybar = 4.12500e-001,  Zbar = 4.12500e-001,  Qyb  = 2.32386e-001,  Qzb  = 2.32386e-001
         Syy  = 3.00736e-002,  Szz  = 3.00736e-002,  Zyy  = 3.54156e-002,  Zzz  = 3.54156e-002
         Iyy  = 1.24054e-002,  Izz  = 1.24054e-002,  Iyz  = 0.00000e+000
         ry   = 3.21627e-001,  rz   = 3.21627e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 6.50000e-001,  Lz   = 6.50000e-001,  Lb   = 6.50000e-001
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2202.75	-127.14	-245.06	-1371.19	-1156.69
TOTAL	-2202.75	-127.14	-245.06	-1371.19	-1156.69

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2202.75 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 4.47
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0590
Pey = (Area*Fy)/Lambda^2 = 10731563.63 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.47
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0590
Pez = (Area*Fy)/Lambda^2 = 10731563.63 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2202.75	-245.06	-1156.69
TOTAL	-2202.75	-245.06	-1156.69

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -245.06 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -1156.69 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 4.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  1.0732e+007 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.650 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.7570e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  1.0732e+007 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        286.93 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       37347.33 kN.
          -. phiPn =  phi*Pn  =      33612.60 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2202.75
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           33612.60

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 8446.14 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 8446.14 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{245.06}{8446.14} = 0.029 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8446.14 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8446.14 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8446.14 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{1156.69}{8446.14} = 0.137 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.033 + [\ 0.029 + 0.137\ ]$$

$$= 0.199 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 436.69 kN.

$$\frac{Vuy}{phiVny} = \frac{436.69}{11427.03} = 0.038 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 396.09 kN.

$$\frac{Vuz}{phiVnz} = \frac{396.09}{11427.03} = 0.035 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105002,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =    31
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_R_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.665,  Flg Width   =      1.010,  Web Center  =      0.972
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos J>.
         Area = 1.21829e-001,  Asy  = 7.69620e-002,  Asz  = 5.06730e-002
         Ybar = 5.05000e-001,  Zbar = 3.32500e-001,  Qyb  = 2.01628e-001,  Qzb  = 2.70576e-001
         Syy  = 2.66680e-002,  Szz  = 3.39465e-002,  Zyy  = 3.07281e-002,  Zzz  = 4.12358e-002
         Iyy  = 8.86711e-003,  Izz  = 1.71430e-002,  Iyz  = 0.00000e+000
         ry   = 2.69784e-001,  rz   = 3.75118e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.13000e+000,  Lz   = 1.13000e+000,  Lb   = 1.13000e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2202.74	-245.06	-450.25	-1156.69	-884.67
TOTAL	-2202.74	-245.06	-450.25	-1156.69	-884.67

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2202.74 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 3.88
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0513
Pey = (Area*Fy)/Lambda^2 = 14203416.51 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 3.88
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0513
Pez = (Area*Fy)/Lambda^2 = 14203416.51 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2202.74	-245.06	-1156.69
TOTAL	-2202.74	-245.06	-1156.69

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -245.06 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -1156.69 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 3.9 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  1.4203e+007 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.130 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.1222e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  1.4203e+007 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        379.75 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       37360.65 kN.
          -. phiPn =  phi*Pn  =      33624.58 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2202.74
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           33624.58

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 8444.25 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 8444.25 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{245.06}{8444.25} = 0.029 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8444.25 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8444.25 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8444.25 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{1156.69}{8444.25} = 0.137 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.033 + [\ 0.029 + 0.137\ ]$$

$$= 0.199 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = I)
-. Applied shear force : Vuy = 432.49 kN.

$$\frac{Vuy}{phiVny} = \frac{432.49}{11427.03} = 0.038 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 10131.97 kN.
-. Vnz = C*Vp = 10131.97 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 391.65 kN.

$$\frac{Vuz}{phiVnz} = \frac{391.65}{10131.97} = 0.039 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105003,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    32
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_R_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.665,  Flg Width   =      1.010,  Web Center  =      0.972
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.665,  Flg Width   =      1.010,  Web Center  =      0.972
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.621,  Flg Width   =      1.430,  Web Center  =      1.392
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 1.21829e-001,  Asy  = 7.69620e-002,  Asz  = 5.06730e-002
         Ybar = 5.05000e-001,  Zbar = 3.32500e-001,  Qyb  = 2.01628e-001,  Qzb  = 2.70576e-001
         Syy  = 2.66680e-002,  Szz  = 3.39465e-002,  Zyy  = 3.07281e-002,  Zzz  = 4.12358e-002
         Iyy  = 8.86711e-003,  Izz  = 1.71430e-002,  Iyz  = 0.00000e+000
         ry   = 2.69784e-001,  rz   = 3.75118e-001
        <Pos I>.
         Area = 1.21829e-001,  Asy  = 7.69620e-002,  Asz  = 5.06730e-002
         Ybar = 5.05000e-001,  Zbar = 3.32500e-001,  Qyb  = 2.01628e-001,  Qzb  = 2.70576e-001
         Syy  = 2.66680e-002,  Szz  = 3.39465e-002,  Zyy  = 3.07281e-002,  Zzz  = 4.12358e-002
         Iyy  = 8.86711e-003,  Izz  = 1.71430e-002,  Iyz  = 0.00000e+000
         ry   = 2.69784e-001,  rz   = 3.75118e-001
        <Pos J>.
         Area = 1.50480e-001,  Asy  = 1.08966e-001,  Asz  = 4.73202e-002
         Ybar = 7.15000e-001,  Zbar = 3.10500e-001,  Qyb  = 2.45488e-001,  Qzb  = 4.45189e-001
         Syy  = 3.31591e-002,  Szz  = 5.40990e-002,  Zyy  = 3.74123e-002,  Zzz  = 6.78468e-002
         Iyy  = 1.02959e-002,  Izz  = 3.86808e-002,  Iyz  = 0.00000e+000
         ry   = 2.61573e-001,  rz   = 5.07001e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 5.92000e-001,  Lz   = 5.92000e-001,  Lb   = 5.92000e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2412.90	-942.49	-1166.57	-572.67	-573.29
TOTAL	-2412.90	-942.49	-1166.57	-572.67	-573.29

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2412.90 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 2.19
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0290
Pey = (Area*Fy)/Lambda^2 = 49929313.95 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 1.58
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0209
Pez = (Area*Fy)/Lambda^2 = 96529324.83 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2412.90	-942.49	-572.67
TOTAL	-2412.90	-942.49	-572.67

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -942.49 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -572.67 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 2.2 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.93 m.
-. DTRf = Dflg/tf = 24.51 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.59 m.
-. DTRw = Dweb/tw = 15.45 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.122 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.59 m.
-. DTRf = Dflg/tw = 15.45 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.93 m.
          -. DTRw  =  Dweb/tf   =   24.51  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.122 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  41998.9307 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  4.9929e+007 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.592 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.6374e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  4.9929e+007 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =        1188.82 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       41984.15 kN.
          -. phiPn =  phi*Pn  =      37785.73 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2412.90
          -. -------  =  ---------------  =          0.06  <  1.000  --->  O.K.
              phiPn           37785.73

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 9191.68 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 9191.68 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{942.49}{9191.68} = 0.103 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 11698.59 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 11698.59 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 11698.59 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{572.67}{11698.59} = 0.049 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.032 + [\ 0.103 + 0.049\ ]$$

$$= 0.183 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 15388.40 kN.
-. Vny = C*Vp = 15388.40 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = I)
-. Applied shear force : Vuy = 427.43 kN.

$$\frac{Vuy}{phiVny} = \frac{427.43}{15388.40} = 0.028 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 9461.58 kN.
-. Vnz = C*Vp = 9461.58 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 386.43 kN.

$$\frac{Vuz}{phiVnz} = \frac{386.43}{9461.58} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105010,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78201e+000,  Lz   = 1.78201e+000,  Lb   = 1.78201e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1711.00	-215.15	-376.38	-323.03	-356.49
TOTAL	-1711.00	-215.15	-376.38	-323.03	-356.49

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1711.00 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834265.40 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1011801.84 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1711.00	-376.38	-356.49
TOTAL	-1711.00	-376.38	-356.49

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -376.38 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -356.49 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  834265.3965 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2335e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834265.3965 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.04 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.74 kN.
          -. phiPn =  phi*Pn  =      18108.66 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1711.00
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           18108.66

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{376.38}{2310.95} = 0.163 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2490.69 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2490.69 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2490.69 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{356.49}{2490.69} = 0.143 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.047 + [\ 0.163 + 0.143\ ]$$

$$= 0.353 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 33.98 kN.

$$\frac{Vuy}{phiVny} = \frac{33.98}{6856.22} = 0.005 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 228.63 kN.

$$\frac{Vuz}{phiVnz} = \frac{228.63}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105011,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04485e+000,  Lz   = 1.04485e+000,  Lb   = 1.04485e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1696.69	-85.16	-215.47	-319.68	-341.67
TOTAL	-1696.69	-85.16	-215.47	-319.68	-341.67

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1696.69 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2847704.96 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4685596.72 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1696.69	-215.47	-341.67
TOTAL	-1696.69	-215.47	-341.67

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -215.47 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -341.67 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2847704.9580 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8649e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2847704.9580 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.06 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.92 kN.
          -. phiPn =  phi*Pn  =      20424.53 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1696.69
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20424.53

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{215.47}{2713.75} = 0.079 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{341.67}{3288.12} = 0.104 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.042 + [\ 0.079 + 0.104\ ]$$

$$= 0.225 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 33.99 kN.

$$\frac{Vuy}{phiVny} = \frac{33.99}{8273.17} = 0.004 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 428.67 kN.

$$\frac{Vuz}{phiVnz} = \frac{428.67}{6094.42} = 0.070 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================

      *. PROJECT     :
      *. MEMBER NO   = 105020,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78200e+000,  Lz   = 1.78200e+000,  Lb   = 1.78200e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1735.48	-243.79	-380.64	-322.73	-354.01
TOTAL	-1735.48	-243.79	-380.64	-322.73	-354.01

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1735.48 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834275.12 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1011813.63 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1735.48	-380.64	-354.01
TOTAL	-1735.48	-380.64	-354.01

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -380.64 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -354.01 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  834275.1170 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2335e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834275.1170 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.04 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.74 kN.
          -. phiPn =  phi*Pn  =      18108.66 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1735.48
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           18108.66

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2310.95 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2310.95 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                380.64
           -. --------  =  ---------------  =  0.165  <  1.000  --->  O.K.
               phiMny             2310.95

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       2490.69 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       2490.69 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       2490.69 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                354.01
           -. --------  =  ---------------  =  0.142  <  1.000  --->  O.K.
               phiMnz             2490.69

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.048 + [  0.165  +  0.142 ]
                      =  0.355  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 31.53 kN.

$$\frac{Vuy}{phiVny} = \frac{31.53}{6856.22} = 0.005 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 216.40 kN.

$$\frac{Vuz}{phiVnz} = \frac{216.40}{6094.42} = 0.036 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105021,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04486e+000,  Lz   = 1.04486e+000,  Lb   = 1.04486e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1722.68	-78.32	-244.13	-320.67	-342.39
TOTAL	-1722.68	-78.32	-244.13	-320.67	-342.39

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1722.68 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2847655.40 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4685515.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1722.68	-244.13	-342.39
TOTAL	-1722.68	-244.13	-342.39

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -244.13 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -342.39 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2847655.3975 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8649e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2847655.3975 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.06 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.92 kN.
          -. phiPn =  phi*Pn  =      20424.53 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1722.68
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20424.53

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{244.13}{2713.75} = 0.090 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{342.39}{3288.12} = 0.104 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.042 + [\ 0.090 + 0.104\ ]$$

$$= 0.236 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 32.44 kN.

$$\frac{Vuy}{phiVny} = \frac{32.44}{8273.17} = 0.004 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 425.30 kN.

$$\frac{Vuz}{phiVnz} = \frac{425.30}{6094.42} = 0.070 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105030,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =    73
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Vert_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.621,  Flg Width   =      0.621,  Web Center  =      0.583
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001
        <Pos I>.
         Area = 8.88340e-002,  Asy  = 4.73202e-002,  Asz  = 4.73202e-002
         Ybar = 3.10500e-001,  Zbar = 3.10500e-001,  Qyb  = 1.27596e-001,  Qzb  = 1.27596e-001
         Syy  = 1.62707e-002,  Szz  = 1.62707e-002,  Zyy  = 1.94456e-002,  Zzz  = 1.94456e-002
         Iyy  = 5.05205e-003,  Izz  = 5.05205e-003,  Iyz  = 0.00000e+000
         ry   = 2.38476e-001,  rz   = 2.38476e-001
        <Pos J>.
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.27800e+000,  Lz   = 2.27800e+000,  Lb   = 2.27800e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	5.05	1311.96	51.44
TOTAL	5.05	1311.96	51.44

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 1311.96 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 51.44 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 13.5 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 20558.41 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{5.05}{20558.41} = 2.456e\text{-}004 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2738.15 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2738.15 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy              1311.96
           -. --------  =  ---------------  =  0.479  <  1.000  --->  O.K.
               phiMny            2738.15

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       2738.15 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       2738.15 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       2738.15 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               51.44
           -. --------  =  ---------------  =  0.019  <  1.000  --->  O.K.
               phiMnz            2738.15

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz   ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =1.228e-004 + [  0.479  +  0.019 ]
                      =  0.498  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 169.49 kN.

$$\text{Vuy} / \text{phiVny} = 169.49 / 6856.22 = 0.025 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6856.22 kN.
-. Vnz = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 340.66 kN.

$$\text{Vuz} / \text{phiVnz} = 340.66 / 6856.22 = 0.050 < 1.000 \text{ ---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
================================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106101,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    10
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-0.0_(1-1/2")
         Shape     = B - Section. (Built-up)
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
         J    = 1.37462e-002,  Cwp  = 1.00000e+028

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.00000e-001,  Lz   = 2.00000e-001,  Lb   = 2.00000e-001
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


================================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================================

      ( ). Factored force/moments caused by unit load case.
           *.Load combination ID =151-
           ------------------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------------
            DL                   0.00         0.00         0.00         0.00         0.00
            LL                   0.00         0.00         0.00         0.00         0.00
            DL+LL                0.00         0.00         0.00         0.00         0.00
            OTHER CASES      -2703.80     -2746.08     -2929.84      -170.76      -290.38
           ------------------------------------------------------------------------------------
            TOTAL            -2703.80     -2746.08     -2929.84      -170.76      -290.38
           ------------------------------------------------------------------------------------
           *.Member end moments caused by gravity load(DL+LL).
             My1G =          0.00,   My2G =          0.00
             Mz1G =          0.00,   Mz2G =          0.00

      ( ). Compute equivalent moment factor (Cmy, Cmz).
           -. Cmy  =  0.850 (User defined or default value)
           -. Cmz  =  0.850 (User defined or default value)
```

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2703.80 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 1.37
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0182
Pey = (Area*Fy)/Lambda^2 =113352140.88 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 1.37
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0182
Pez = (Area*Fy)/Lambda^2 =113352140.88 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2703.80	-2929.84	-290.38
TOTAL	-2703.80	-2929.84	-290.38

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -2929.84 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -290.38 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 1.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

---

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = Cw - tw = 0.67 m.
-. DTRw = Dweb/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa2 = A_eff/Area = 1.000 (about z-axis).

( ). Calculate reduction factor of stiffened elements (Qa).
-. Qa = 1.0 (Stiffened elements are not Slender.)

( ). Full reduction factor for slender section (QsQa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Q = Qs*Qa = 1.000

-. Po = Q*Fy*Area = 37401.8498 kN.

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      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                       pi^2 * E
           -. Pe_FB = -----------Area  =  1.1335e+008 kN.
                       (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      0.200 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.9120e+039 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  =  1.1335e+008 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =           0.90
           -. Pe/Po =        3030.66 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       37396.68 kN.
           -. phiPn =  phi*Pn  =      33657.02 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              2703.80
           -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
               phiPn            33657.02

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       8447.92 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       8447.92 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy             2929.84
           -. --------  =  ---------------  =  0.347  <  1.000  --->  O.K.
               phiMny           8447.92

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================
```

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8447.92 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8447.92 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8447.92 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$\text{-. } \frac{Muz}{phiMnz} = \frac{290.38}{8447.92} = 0.034 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$\text{-. ComRat} = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.040 + [\ 0.347 + 0.034\ ]$$

$$= 0.421 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = 3/4)
-. Applied shear force : Vuy = 1548.76 kN.

$$\text{-. } \frac{Vuy}{phiVny} = \frac{1548.76}{11427.03} = 0.136 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = 3/4)
-. Applied shear force : Vuz = 920.07 kN.

$$\frac{Vuz}{phiVnz} = \frac{920.07}{11427.03} = 0.081 < 1.000 \text{ ---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 106110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78179e+000,  Lz   = 1.78179e+000,  Lb   = 1.78179e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-908.57	-544.14	-588.92	-298.48	-45.65
TOTAL	-908.57	-544.14	-588.92	-298.48	-45.65

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 908.57 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979237.47 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611231.48 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-908.57	-544.14	-298.48
TOTAL	-908.57	-544.14	-298.48

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -544.14 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -298.48 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  979237.4696 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8516e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979237.4696 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.01 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.46 kN.
          -. phiPn =  phi*Pn  =      20294.52 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               908.57
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20294.52

==============================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
==============================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{544.14}{2712.54} = 0.201 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{298.48}{3285.85} = 0.091 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.022 + [\ 0.201 + 0.091\ ]$$

$$= 0.314 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 378.51 kN.

$$\text{Vuy} / \text{phiVny} = 378.51 / 6856.22 = 0.055 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 534.73 kN.

$$\text{Vuz} / \text{phiVnz} = 534.73 / 6094.42 = 0.088 < 1.000 \text{ ---> O.K.}$$

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04509e+000,  Lz   = 1.04509e+000,  Lb   = 1.04509e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-886.59	-1019.89	-544.25	-544.83	-301.37
TOTAL	-886.59	-1019.89	-544.25	-544.83	-301.37

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 886.59 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2846357.01 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4683378.81 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-886.59	-544.25	-301.37
TOTAL	-886.59	-544.25	-301.37

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -544.25 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -301.37 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2846357.0055 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8636e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2846357.0055 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.89 kN.
          -. phiPn =  phi*Pn  =      20424.50 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              886.59
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20424.50

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               544.25
           -. --------  =  ---------------  =  0.201  <  1.000  --->  O.K.
               phiMny            2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               301.37
           -. --------  =  ---------------  =  0.092  <  1.000  --->  O.K.
               phiMnz            3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.022 + [  0.201  +  0.092 ]
                      =  0.314  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 372.65 kN.

$$\frac{Vuy}{phiVny} = \frac{372.65}{8273.17} = 0.045 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 558.18 kN.

$$\frac{Vuz}{phiVnz} = \frac{558.18}{6094.42} = 0.092 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106120,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78179e+000,  Lz   = 1.78179e+000,  Lb   = 1.78179e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3670.89	-827.60	-761.39	-235.81	-133.23
TOTAL	-3670.89	-827.60	-761.39	-235.81	-133.23

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3670.89 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834473.26 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1012053.93 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3670.89	-761.39	-133.23
TOTAL	-3670.89	-761.39	-133.23

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -761.39 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -133.23 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  834473.2553 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2338e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834473.2553 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.05 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.79 kN.
          -. phiPn =  phi*Pn  =      18108.71 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3670.89
          -. -------  =  ---------------  =          0.20  <  1.000  --->  O.K.
              phiPn           18108.71

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{761.39}{2310.95} = 0.329 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2490.69 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2490.69 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2490.69 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{133.23}{2490.69} = 0.053 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn > 0.20 ---> Formula(6.9.2.2-1)

$$-.\ ComRat = \frac{Pu}{phiPn} + \frac{8}{9}\left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$
$$= 0.203 + (8/9)*[\ 0.329 + 0.053\ ]$$
$$= 0.543 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 342.49 kN.

$$\frac{Vuy}{phiVny} = \frac{342.49}{6856.22} = 0.050 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 203.73 kN.

$$\frac{Vuz}{phiVnz} = \frac{203.73}{6094.42} = 0.033 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106121,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04516e+000,  Lz   = 1.04516e+000,  Lb   = 1.04516e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3662.30	-497.78	-827.52	-451.88	-239.03
TOTAL	-3662.30	-497.78	-827.52	-451.88	-239.03

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3662.30 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2846005.24 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4682800.01 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3662.30	-827.52	-239.03
TOTAL	-3662.30	-827.52	-239.03

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -827.52 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -239.03 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 2846005.2357 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8632e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2846005.2357 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        124.99 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.88 kN.
          -. phiPn =  phi*Pn  =      20424.49 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3662.30
          -. -------  =  ---------------  =          0.18  <  1.000  --->  O.K.
              phiPn           20424.49

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{827.52}{2713.75} = 0.305 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{239.03}{3288.12} = 0.073 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.090 + [\ 0.305 + 0.073\ ]$$

$$= 0.467 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 336.40 kN.

$$\frac{Vuy}{phiVny} = \frac{336.40}{8273.17} = 0.041 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 385.71 kN.

$$\frac{Vuz}{phiVnz} = \frac{385.71}{6094.42} = 0.063 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.17027e+000,  Lz   = 2.17027e+000,  Lb   = 2.17027e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1984.03	-680.64	-262.86	-238.32	-181.08
TOTAL	-1984.03	-680.64	-262.86	-238.32	-181.08

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1984.03 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.98
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1848
Pey = (Area*Fy)/Lambda^2 = 686274.36 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.51
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1389
Pez = (Area*Fy)/Lambda^2 = 1214474.95 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1984.03	-680.64	-238.32
TOTAL	-1984.03	-680.64	-238.32

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -680.64 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -238.32 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.0 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  686274.3588 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.170 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.2759e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  686274.3588 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          29.29 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23094.39 kN.
          -. phiPn =  phi*Pn  =      20784.95 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1984.03
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           20784.95

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.86 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.86 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{680.64}{2819.86} = 0.241 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.35 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.35 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.35 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{238.32}{3511.35} = 0.068 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.048 + [\ 0.241 + 0.068\ ]$$

$$= 0.357 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 217.57 kN.

$$\frac{Vuy}{phiVny} = \frac{217.57}{6856.22} = 0.032 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 318.11 kN.

$$\frac{Vuz}{phiVnz} = \frac{318.11}{6094.42} = 0.052 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.60824e-001,  Lz   = 8.60824e-001,  Lb   = 8.60824e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2001.48	-732.48	-680.19	-311.80	-244.51
TOTAL	-2001.48	-732.48	-680.19	-311.80	-244.51

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2001.48 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0733
Pey = (Area*Fy)/Lambda^2 = 4362107.63 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.17
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0551
Pez = (Area*Fy)/Lambda^2 = 7719464.34 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2001.48	-680.19	-244.51
TOTAL	-2001.48	-680.19	-244.51

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -680.19 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -244.51 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 4362107.6267 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.861 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.9891e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4362107.6267 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        186.20 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23374.12 kN.
          -. phiPn =  phi*Pn  =      21036.71 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2001.48
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           21036.71

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.98 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.98 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{680.19}{2821.98} = 0.241 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.72 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.72 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.72 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{244.51}{3515.72} = 0.070 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.048 + [\ 0.241 + 0.070\ ]$$

$$= 0.358 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 209.84 kN.

$$\frac{Vuy}{phiVny} = \frac{209.84}{8654.07} = 0.024 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 232.34 kN.

$$\frac{Vuz}{phiVnz} = \frac{232.34}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.25027e+000,  Lz   = 2.25027e+000,  Lb   = 2.25027e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1375.48	-367.26	-340.58	-225.03	-289.31
TOTAL	-1375.48	-367.26	-340.58	-225.03	-289.31

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1375.48 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.91
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1971
Pey = (Area*Fy)/Lambda^2 = 523186.11 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 13.54
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1790
Pez = (Area*Fy)/Lambda^2 = 634523.11 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1375.48	-340.58	-289.31
TOTAL	-1375.48	-340.58	-289.31

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -340.58 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -289.31 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.9 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  523186.1124 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.250 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 7.7354e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  523186.1124 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          25.74 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       19999.10 kN.
          -. phiPn =  phi*Pn  =      17999.19 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1375.48
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           17999.19

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.14 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.14 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{340.58}{2310.14} = 0.147 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2489.66 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2489.66 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2489.66 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{289.31}{2489.66} = 0.116 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.038 + [\ 0.147 + 0.116\ ]$$

$$= 0.302 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 262.48 kN.

$$\frac{Vuy}{phiVny} = \frac{262.48}{6856.22} = 0.038 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 219.20 kN.

$$\frac{Vuz}{phiVnz} = \frac{219.20}{6094.42} = 0.036 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.78708e-001,  Lz   = 9.78708e-001,  Lb   = 9.78708e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1730.12	-558.65	-530.59	-242.19	-96.46
TOTAL	-1730.12	-558.65	-530.59	-242.19	-96.46

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1730.12 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.30
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0833
Pey = (Area*Fy)/Lambda^2 = 3374574.47 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.74
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0626
Pez = (Area*Fy)/Lambda^2 = 5971862.57 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1730.12	-530.59	-96.46
TOTAL	-1730.12	-530.59	-96.46

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -530.59 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -96.46 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3374574.4661 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.979 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.0860e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3374574.4661 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        144.05 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23358.75 kN.
          -. phiPn =  phi*Pn  =      21022.88 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1730.12
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21022.88

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.78 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.78 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{530.59}{2821.78} = 0.188 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.33 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.33 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.33 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{96.46}{3515.33} = 0.027 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.041 + [\ 0.188 + 0.027\ ]$$

$$= 0.257 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 258.10 kN.

$$\frac{Vuy}{phiVny} = \frac{258.10}{8654.07} = 0.030 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 183.13 kN.

$$\frac{Vuz}{phiVnz} = \frac{183.13}{6094.42} = 0.030 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106201,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    10
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-0.0_(1-1/2")
         Shape     = B - Section. (Built-up)
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
         J    = 1.37462e-002,  Cwp  = 1.00000e+028

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.00000e-001,  Lz   = 2.00000e-001,  Lb   = 2.00000e-001
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


================================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================================

      ( ). Factored force/moments caused by unit load case.
           *.Load combination ID =151-
           ------------------------------------------------------------------------------------
            Load Case              Pu          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------------
            DL                   0.00         0.00         0.00         0.00         0.00
            LL                   0.00         0.00         0.00         0.00         0.00
            DL+LL                0.00         0.00         0.00         0.00         0.00
            OTHER CASES      -2593.45     -2677.81     -2852.88      -493.32      -670.60
           ------------------------------------------------------------------------------------
            TOTAL            -2593.45     -2677.81     -2852.88      -493.32      -670.60
           ------------------------------------------------------------------------------------
           *.Member end moments caused by gravity load(DL+LL).
             My1G =          0.00,   My2G =          0.00
             Mz1G =          0.00,   Mz2G =          0.00

      ( ). Compute equivalent moment factor (Cmy, Cmz).
           -. Cmy  =  0.850 (User defined or default value)
           -. Cmz  =  0.850 (User defined or default value)
```

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2593.45 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 1.37
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0182
Pey = (Area*Fy)/Lambda^2 =113352140.88 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 1.37
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0182
Pez = (Area*Fy)/Lambda^2 =113352140.88 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2593.45	-2852.88	-670.60
TOTAL	-2593.45	-2852.88	-670.60

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -2852.88 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -670.60 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 1.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

---

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = Cw - tw = 0.67 m.
-. DTRw = Dweb/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa2 = A_eff/Area = 1.000 (about z-axis).

( ). Calculate reduction factor of stiffened elements (Qa).
-. Qa = 1.0 (Stiffened elements are not Slender.)

( ). Full reduction factor for slender section (QsQa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Q = Qs*Qa = 1.000

-. Po = Q*Fy*Area = 37401.8498 kN.

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      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                       pi^2 * E
           -. Pe_FB = -----------Area  =  1.1335e+008 kN.
                       (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      0.200 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.9120e+039 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  =  1.1335e+008 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =           0.90
           -. Pe/Po =        3030.66 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       37396.68 kN.
           -. phiPn =  phi*Pn  =      33657.02 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              2593.45
           -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
               phiPn            33657.02

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       8447.92 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       8447.92 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy             2852.88
           -. --------  =  ---------------  =  0.338  <  1.000  --->  O.K.
               phiMny           8447.92

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================
```

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8447.92 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8447.92 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8447.92 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{670.60}{8447.92} = 0.079 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.039 + [\ 0.338 + 0.079\ ]$$

$$= 0.456 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = 3/4)
-. Applied shear force : Vuy = 1590.90 kN.

$$-.\ \frac{Vuy}{phiVny} = \frac{1590.90}{11427.03} = 0.139 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = 3/4)
-. Applied shear force : Vuz = 876.44 kN.

$$-.\ \frac{Vuz}{phiVnz} = \frac{876.44}{11427.03} = 0.077 < 1.000 \ ---> \ O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 106210,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78179e+000,  Lz   = 1.78179e+000,  Lb   = 1.78179e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3686.39	-860.69	-756.06	-236.68	-144.64
TOTAL	-3686.39	-860.69	-756.06	-236.68	-144.64

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3686.39 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834473.26 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1012053.93 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3686.39	-756.06	-144.64
TOTAL	-3686.39	-756.06	-144.64

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -756.06 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -144.64 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  834473.2553 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2338e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834473.2553 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.05 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.79 kN.
          -. phiPn =  phi*Pn  =      18108.71 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3686.39
          -. -------  =  ---------------  =          0.20  <  1.000  --->  O.K.
              phiPn           18108.71

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{756.06}{2310.95} = 0.327 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2490.69 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2490.69 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2490.69 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{144.64}{2490.69} = 0.058 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn > 0.20 ---> Formula(6.9.2.2-1)

$$-.\ ComRat = \frac{Pu}{phiPn} + \frac{8}{9}\left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$
$$= 0.204 + (8/9)*[\ 0.327 + 0.058\ ]$$
$$= 0.546 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 311.55 kN.

$$\frac{Vuy}{phiVny} = \frac{311.55}{6856.22} = 0.045 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 222.46 kN.

$$\frac{Vuz}{phiVnz} = \frac{222.46}{6094.42} = 0.037 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106211,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04509e+000,  Lz   = 1.04509e+000,  Lb   = 1.04509e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3680.19	-550.56	-860.52	-443.85	-241.74
TOTAL	-3680.19	-550.56	-860.52	-443.85	-241.74

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3680.19 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2846357.01 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4683378.81 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3680.19	-860.52	-241.74
TOTAL	-3680.19	-860.52	-241.74

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -860.52 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -241.74 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2846357.0055 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8636e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2846357.0055 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.89 kN.
          -. phiPn =  phi*Pn  =      20424.50 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3680.19
          -. -------  =  ---------------  =          0.18  <  1.000  --->  O.K.
              phiPn           20424.50

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{860.52}{2713.75} = 0.317 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{241.74}{3288.12} = 0.074 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.090 + [\ 0.317 + 0.074\ ]$$

$$= 0.481 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 304.84 kN.

$$\frac{Vuy}{phiVny} = \frac{304.84}{8273.17} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 370.04 kN.

$$\frac{Vuz}{phiVnz} = \frac{370.04}{6094.42} = 0.061 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78249e+000,  Lz   = 1.78249e+000,  Lb   = 1.78249e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-869.37	-586.37	-598.40	-209.08	-150.76
TOTAL	-869.37	-586.37	-598.40	-209.08	-150.76

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 869.37 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 833814.82 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.73
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1418
Pez = (Area*Fy)/Lambda^2 = 1011255.38 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-869.37	-598.40	-150.76
TOTAL	-869.37	-598.40	-150.76

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -598.40 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -150.76 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  833814.8222 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2328e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  833814.8222 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         41.02 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.63 kN.
          -. phiPn =  phi*Pn  =      18108.56 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              869.37
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           18108.56

==========================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2310.95 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2310.95 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                598.40
           -. --------  =  ---------------  =  0.259  <  1.000  --->  O.K.
               phiMny             2310.95

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       2490.69 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       2490.69 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       2490.69 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                150.76
           -. --------  =  ---------------  =  0.061  <  1.000  --->  O.K.
               phiMnz             2490.69

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.024 + [  0.259  +  0.061 ]
                      =  0.343  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 351.82 kN.
Vuy 351.82
-. -------- = --------------- = 0.051 < 1.000 ---> O.K.
phiVny 6856.22

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 561.49 kN.
Vuz 561.49
-. -------- = --------------- = 0.092 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04454e+000,  Lz   = 1.04454e+000,  Lb   = 1.04454e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-899.88	-1075.30	-586.50	-365.93	-215.98
TOTAL	-899.88	-1075.30	-586.50	-365.93	-215.98

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 899.88 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2849377.98 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4688349.51 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-899.88	-586.50	-215.98
TOTAL	-899.88	-586.50	-215.98

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -586.50 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -215.98 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2849377.9844 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8666e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2849377.9844 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.14 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.97 kN.
          -. phiPn =  phi*Pn  =      20424.57 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              899.88
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20424.57

==========================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                586.50
           -. --------  =  ---------------  =  0.216  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                215.98
           -. --------  =  ---------------  =  0.066  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.022 + [  0.216  +  0.066 ]
                      =  0.304  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 346.00 kN.
Vuy 346.00
-. -------- = --------------- = 0.042 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 580.97 kN.
Vuz 580.97
-. -------- = --------------- = 0.095 < 1.000 ---> O.K.
phiVnz 6094.42

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      *. PROJECT     :
      *. MEMBER NO   = 106230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.22079e+000,  Lz   = 2.22079e+000,  Lb   = 2.22079e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1957.29	-662.34	-259.92	-198.03	-149.92
TOTAL	-1957.29	-662.34	-259.92	-198.03	-149.92

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1957.29 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.30
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1891
Pey = (Area*Fy)/Lambda^2 = 655403.24 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.75
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1421
Pez = (Area*Fy)/Lambda^2 = 1159843.44 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1957.29	-662.34	-198.03
TOTAL	-1957.29	-662.34	-198.03

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -662.34 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -198.03 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  655403.2379 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.221 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.9936e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  655403.2379 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         27.98 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23078.85 kN.
          -. phiPn =  phi*Pn  =      20770.97 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1957.29
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20770.97

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.78 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.78 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               662.34
           -. --------  =  ---------------  =  0.235  <  1.000  --->  O.K.
               phiMny            2819.78

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.18 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.18 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.18 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               198.03
           -. --------  =  ---------------  =  0.056  <  1.000  --->  O.K.
               phiMnz            3511.18

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.047 + [  0.235  +  0.056 ]
                      =  0.338  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 216.07 kN.

$$\frac{Vuy}{phiVny} = \frac{216.07}{6856.22} = 0.032 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 307.26 kN.

$$\frac{Vuz}{phiVnz} = \frac{307.26}{6094.42} = 0.050 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.76746e-001,  Lz   = 8.76746e-001,  Lb   = 8.76746e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1972.50	-710.54	-663.03	-296.92	-202.66
TOTAL	-1972.50	-710.54	-663.03	-296.92	-202.66

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1972.50 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.65
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0746
Pey = (Area*Fy)/Lambda^2 = 4205114.81 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.25
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0561
Pez = (Area*Fy)/Lambda^2 = 7441639.82 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1972.50	-663.03	-202.66
TOTAL	-1972.50	-663.03	-202.66

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -663.03 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -202.66 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.6 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 4205114.8124 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.877 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.8455e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4205114.8124 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        179.50 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23372.16 kN.
          -. phiPn =  phi*Pn  =      21034.95 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1972.50
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           21034.95

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{663.03}{2821.95} = 0.235 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.67 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.67 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.67 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{202.66}{3515.67} = 0.058 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.047 + [\ 0.235 + 0.058\ ]$$

$$= 0.339 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 211.47 kN.

$$\frac{Vuy}{phiVny} = \frac{211.47}{8654.07} = 0.024 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 228.82 kN.

$$\frac{Vuz}{phiVnz} = \frac{228.82}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.29891e+000,  Lz   = 2.29891e+000,  Lb   = 2.29891e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1342.00	-384.85	-363.87	-299.60	-265.47
TOTAL	-1342.00	-384.85	-363.87	-299.60	-265.47

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1342.00 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 15.24
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.2014
Pey = (Area*Fy)/Lambda^2 = 501280.16 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 13.83
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1829
Pez = (Area*Fy)/Lambda^2 = 607955.45 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1342.00	-363.87	-265.47
TOTAL	-1342.00	-363.87	-265.47

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -363.87 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -265.47 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 15.2 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  501280.1645 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.299 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 7.4115e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  501280.1645 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         24.66 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       19984.89 kN.
          -. phiPn =  phi*Pn  =      17986.40 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1342.00
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           17986.40

=============================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
=============================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.06 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.06 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{363.87}{2310.06} = 0.158 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2489.55 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2489.55 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2489.55 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{265.47}{2489.55} = 0.107 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.037 + [\ 0.158 + 0.107\ ]$$

$$= 0.301 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 237.84 kN.

$$\frac{Vuy}{phiVny} = \frac{237.84}{6856.22} = 0.035 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 247.95 kN.

$$\frac{Vuz}{phiVnz} = \frac{247.95}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.96585e-001,  Lz   = 9.96585e-001,  Lb   = 9.96585e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1613.48	-623.52	-564.90	-307.77	-171.56
TOTAL	-1613.48	-623.52	-564.90	-307.77	-171.56

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1613.48 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.42
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0848
Pey = (Area*Fy)/Lambda^2 = 3254590.06 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.83
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0638
Pez = (Area*Fy)/Lambda^2 = 5759530.50 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1613.48	-564.90	-171.56
TOTAL	-1613.48	-564.90	-171.56

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -564.90 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -171.56 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3254590.0644 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.997 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.9763e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3254590.0644 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        138.93 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23356.25 kN.
          -. phiPn =  phi*Pn  =      21020.63 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1613.48
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21020.63

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.76 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.76 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{564.90}{2821.76} = 0.200 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.27 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.27 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.27 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{171.56}{3515.27} = 0.049 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.038 + [\ 0.200 + 0.049\ ]$$

$$= 0.287 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 232.41 kN.

$$\frac{Vuy}{phiVny} = \frac{232.41}{8654.07} = 0.027 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 221.58 kN.

$$\frac{Vuz}{phiVnz} = \frac{221.58}{6094.42} = 0.036 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78167e+000,  Lz   = 1.78167e+000,  Lb   = 1.78167e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1059.41	-438.84	-76.93	-482.45	-174.70
TOTAL	-1059.41	-438.84	-76.93	-482.45	-174.70

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1059.41 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979368.58 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611447.20 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1059.41	-438.84	-482.45
TOTAL	-1059.41	-438.84	-482.45

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -438.84 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -482.45 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979368.5756 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8529e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979368.5756 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.01 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.49 kN.
          -. phiPn =  phi*Pn  =      20294.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1059.41
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{438.84}{2712.54} = 0.162 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{482.45}{3285.85} = 0.147 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.026 + [\ 0.162 + 0.147\ ]$$

$$= 0.335 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 371.83 kN.

$$\frac{Vuy}{phiVny} = \frac{371.83}{6856.22} = 0.054 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = I)
-. Applied shear force : Vuz = 372.16 kN.

$$\frac{Vuz}{phiVnz} = \frac{372.16}{6094.42} = 0.061 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04489e+000,  Lz   = 1.04489e+000,  Lb   = 1.04489e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1076.78	-530.72	-438.66	-878.74	-502.97
TOTAL	-1076.78	-530.72	-438.66	-878.74	-502.97

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1076.78 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2847475.43 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4685219.05 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1076.78	-438.66	-502.97
TOTAL	-1076.78	-438.66	-502.97

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -438.66 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -502.97 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2847475.4291 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8647e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2847475.4291 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.05 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.92 kN.
          -. phiPn =  phi*Pn  =      20424.52 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1076.78
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20424.52

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                438.66
           -. --------  =  ---------------  =  0.162  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                502.97
           -. --------  =  ---------------  =  0.153  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.026 + [  0.162  +  0.153 ]
                      =  0.341  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 366.59 kN.

$$\frac{Vuy}{phiVny} = \frac{366.59}{8273.17} = 0.044 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = J)
-. Applied shear force : Vuz = 249.04 kN.

$$\frac{Vuz}{phiVnz} = \frac{249.04}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.17107e+000,  Lz   = 2.17107e+000,  Lb   = 2.17107e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2263.26	-1038.87	-579.42	-441.28	-61.36
TOTAL	-2263.26	-1038.87	-579.42	-441.28	-61.36

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2263.26 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.98
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1848
Pey = (Area*Fy)/Lambda^2 = 685766.23 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.51
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1389
Pez = (Area*Fy)/Lambda^2 = 1213575.73 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2263.26	-1038.87	-441.28
TOTAL	-2263.26	-1038.87	-441.28

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -1038.87 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -441.28 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.0 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  685766.2296 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.171 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.2713e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  685766.2296 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          29.27 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23094.15 kN.
          -. phiPn =  phi*Pn  =      20784.73 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2263.26
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20784.73

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.86 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.86 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy              1038.87
           -. --------  =  ---------------  =  0.368  <  1.000  --->  O.K.
               phiMny            2819.86

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.35 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.35 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.35 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               441.28
           -. --------  =  ---------------  =  0.126  <  1.000  --->  O.K.
               phiMnz            3511.35

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.054 + [  0.368  +  0.126 ]
                      =  0.549  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = J)
-. Applied shear force : Vuy = 262.45 kN.

$$\frac{Vuy}{phiVny} = \frac{262.45}{6856.22} = 0.038 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 733.93 kN.

$$\frac{Vuz}{phiVnz} = \frac{733.93}{6094.42} = 0.120 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.60384e-001,  Lz   = 8.60384e-001,  Lb   = 8.60384e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2332.14	-1436.45	-1036.58	-649.36	-448.95
TOTAL	-2332.14	-1436.45	-1036.58	-649.36	-448.95

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2332.14 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.57
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0736
Pey = (Area*Fy)/Lambda^2 = 4199672.47 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.34
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0574
Pez = (Area*Fy)/Lambda^2 = 6910115.98 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2332.14	-1036.58	-448.95
TOTAL	-2332.14	-1036.58	-448.95

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -1036.58 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -448.95 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.6 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 4199672.4685 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.860 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.2251e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4199672.4685 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        184.44 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22718.38 kN.
          -. phiPn =  phi*Pn  =      20446.55 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2332.14
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20446.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2714.05 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2714.05 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{1036.58}{2714.05} = 0.382 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.69 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.69 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.69 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{448.95}{3288.69} = 0.137 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.057 + [\ 0.382 + 0.137\ ]$$

$$= 0.575 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = J)
-. Applied shear force : Vuy = 258.01 kN.

$$\frac{Vuy}{phiVny} = \frac{258.01}{8273.17} = 0.031 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 529.16 kN.

$$\frac{Vuz}{phiVnz} = \frac{529.16}{6094.42} = 0.087 < 1.000 \quad ---> \quad O.K.$$

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 107140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.23133e+000,  Lz   = 2.23133e+000,  Lb   = 2.23133e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      ( ). Compute moment magnification factors(B1y,B1z).
           -. If tension or bending member.
           -. Assumed   B1y  =  1.00
           -. Assumed   B1z  =  1.00

      ( ). Magnification factors for sidesway moments(B2y,B2z).
           -. B2y   =  1.00 (Default value)
           -. B2z   =  1.00 (Default value)

      ( ). Given factored axial forces and moments at <I>.
           ------------------------------------------------------------------
            Load Case             Pu                My                 Mz
           ------------------------------------------------------------------
            DL                  0.00              0.00               0.00
            LL                  0.00              0.00               0.00
            DL+LL               0.00              0.00               0.00
            OTHER CASES      1785.55            877.48             408.33
           ------------------------------------------------------------------
            TOTAL            1785.55            877.48             408.33
           ------------------------------------------------------------------

      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =      877.48 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =      408.33 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial tension member (l/r).
           [ AASHTO-LRFD12 Specification 6.8.4 ]
           -. l/r  =    14.4  <   200.0  --->  O.K.

      ( ). Calculate axial tensile strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.8.2.1-1 ]
           -. Resistance factor for tension  :  phi = 0.95
           -. phiPn  =  phi*Fy*Ag  =      22255.39 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1785.55
           -. -------  =  ---------------  =  0.080  <  1.000  --->  O.K.
              phiPn           22255.39

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
============================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.76 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.76 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                877.48
           -. --------  =  ---------------  =  0.311  <  1.000  --->  O.K.
               phiMny             2819.76

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.15 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.15 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.15 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                408.33
           -. --------  =  ---------------  =  0.116  <  1.000  --->  O.K.
               phiMnz             3511.15

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.040 + [  0.311  +  0.116 ]
                      =  0.468  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuy = 250.13 kN.

$$\frac{Vuy}{phiVny} = \frac{250.13}{6856.22} = 0.036 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 643.78 kN.

$$\frac{Vuz}{phiVnz} = \frac{643.78}{6094.42} = 0.106 < 1.000 \quad ---> \quad O.K.$$

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 107141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.49316e-001,  Lz   = 9.49316e-001,  Lb   = 9.49316e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	1834.64	877.55	413.82
TOTAL	1834.64	877.55	413.82

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 877.55 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 413.82 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 6.1 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 22255.39 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{1834.64}{22255.39} = 0.082 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2821.83 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2821.83 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               877.55
           -. --------  =  ---------------  =  0.311  <  1.000  --->  O.K.
              phiMny            2821.83

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.43 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.43 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.43 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               413.82
           -. --------  =  ---------------  =  0.118  <  1.000  --->  O.K.
              phiMnz            3515.43

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.041 + [  0.311  +  0.118 ]
                      =  0.470  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuy = 246.80 kN.

$$\frac{Vuy}{phiVny} = \frac{246.80}{8654.07} = 0.029 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 483.56 kN.

$$\frac{Vuz}{phiVnz} = \frac{483.56}{6094.42} = 0.079 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 107220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78167e+000,  Lz   = 1.78167e+000,  Lb   = 1.78167e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1110.84	-466.25	-76.15	-504.06	-185.34
TOTAL	-1110.84	-466.25	-76.15	-504.06	-185.34

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1110.84 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979368.58 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611447.20 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1110.84	-466.25	-504.06
TOTAL	-1110.84	-466.25	-504.06

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -466.25 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -504.06 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  =  979368.5756 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.782 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8529e+037 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  =  979368.5756 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =         43.01 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22549.49 kN.
           -. phiPn =  phi*Pn  =      20294.54 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1110.84
           -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{466.25}{2712.54} = 0.172 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{504.06}{3285.85} = 0.153 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.027 + [\ 0.172 + 0.153\ ]$$

$$= 0.353 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 386.04 kN.

$$\frac{Vuy}{phiVny} = \frac{386.04}{6856.22} = 0.056 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = I)
-. Applied shear force : Vuz = 368.74 kN.

$$\frac{Vuz}{phiVnz} = \frac{368.74}{6094.42} = 0.061 < 1.000 \quad ---> \quad O.K.$$

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------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 107221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04489e+000,  Lz   = 1.04489e+000,  Lb   = 1.04489e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1129.23	-580.90	-466.24	-920.93	-524.02
TOTAL	-1129.23	-580.90	-466.24	-920.93	-524.02

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1129.23 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2847475.43 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4685219.05 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1129.23	-466.24	-524.02
TOTAL	-1129.23	-466.24	-524.02

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -466.24 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -524.02 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2847475.4291 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8647e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2847475.4291 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.05 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.92 kN.
          -. phiPn =  phi*Pn  =      20424.52 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1129.23
          -. -------  =  ---------------  =          0.06  <  1.000  --->  O.K.
              phiPn           20424.52

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{466.24}{2713.75} = 0.172 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{524.02}{3288.12} = 0.159 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.028 + [\ 0.172 + 0.159\ ]$$

$$= 0.359 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 380.24 kN.
Vuy 380.24
-. -------- = --------------- = 0.046 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = J)
-. Applied shear force : Vuz = 243.21 kN.
Vuz 243.21
-. -------- = --------------- = 0.040 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.22143e+000,  Lz   = 2.22143e+000,  Lb   = 2.22143e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


================================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================================
```

( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	1597.19	955.48	427.28
TOTAL	1597.19	955.48	427.28

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 955.48 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 427.28 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 14.3 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 22255.39 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{1597.19}{22255.39} = 0.072 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.78 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.78 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{955.48}{2819.78} = 0.339 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.18 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.18 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.18 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{427.28}{3511.18} = 0.122 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.036 + [\ 0.339 + 0.122\ ]$$

$$= 0.496 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 263.64 kN.
Vuy 263.64
-. -------- = --------------- = 0.038 < 1.000 ---> O.K.
phiVny 6856.22

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 694.68 kN.
Vuz 694.68
-. -------- = --------------- = 0.114 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.76695e-001,  Lz   = 8.76695e-001,  Lb   = 8.76695e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	1663.69	955.52	426.71
TOTAL	1663.69	955.52	426.71

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 955.52 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 426.71 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 5.7 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 21631.50 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\frac{Pu}{phiPn} = \frac{1663.69}{21631.50} = 0.077 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2714.02 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2714.02 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{955.52}{2714.02} = 0.352 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.64 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.64 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.64 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{426.71}{3288.64} = 0.130 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.038 + [\ 0.352 + 0.130\ ]$$

$$= 0.520 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 269.40 kN.
Vuy 269.40
-. -------- = --------------- = 0.033 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 513.50 kN.
Vuz 513.50
-. -------- = --------------- = 0.084 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.28104e+000,  Lz   = 2.28104e+000,  Lb   = 2.28104e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2175.12	-815.19	-538.77	-415.30	-66.45
TOTAL	-2175.12	-815.19	-538.77	-415.30	-66.45

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2175.12 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.69
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1942
Pey = (Area*Fy)/Lambda^2 = 621241.50 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.04
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1460
Pez = (Area*Fy)/Lambda^2 = 1099388.64 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2175.12	-815.19	-415.30
TOTAL	-2175.12	-815.19	-415.30

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -815.19 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -415.30 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.7 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  621241.4968 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.281 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.6812e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  621241.4968 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          26.52 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23059.87 kN.
          -. phiPn =  phi*Pn  =      20753.89 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2175.12
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           20753.89

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.68 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.68 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{815.19}{2819.68} = 0.289 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3510.98 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3510.98 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3510.98 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{415.30}{3510.98} = 0.118 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.052 + [\ 0.289 + 0.118\ ]$$

$$= 0.460 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 266.78 kN.
Vuy 266.78
-. -------- = --------------- = 0.039 < 1.000 ---> O.K.
phiVny 6856.22

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 609.51 kN.
Vuz 609.51
-. -------- = --------------- = 0.100 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 107241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.66752e-001,  Lz   = 9.66752e-001,  Lb   = 9.66752e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2213.40	-1169.82	-816.72	-675.79	-412.89
TOTAL	-2213.40	-1169.82	-816.72	-675.79	-412.89

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2213.40 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.23
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0823
Pey = (Area*Fy)/Lambda^2 = 3458555.19 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.68
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0619
Pez = (Area*Fy)/Lambda^2 = 6120480.23 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2213.40	-816.72	-412.89
TOTAL	-2213.40	-816.72	-412.89

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -816.72 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -412.89 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.2 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3458555.1934 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.967 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.1628e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3458555.1934 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        147.63 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23360.40 kN.
          -. phiPn =  phi*Pn  =      21024.36 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2213.40
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           21024.36

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.80 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.80 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{816.72}{2821.80} = 0.289 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.37 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.37 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.37 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{412.89}{3515.37} = 0.117 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.053 + [\ 0.289 + 0.117\ ]$$

$$= 0.460 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 275.74 kN.

$$\frac{Vuy}{phiVny} = \frac{275.74}{8654.07} = 0.032 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 460.92 kN.

$$\frac{Vuz}{phiVnz} = \frac{460.92}{6094.42} = 0.076 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78134e+000,  Lz   = 1.78134e+000,  Lb   = 1.78134e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1094.96	-396.07	-357.85	-530.58	-129.68
TOTAL	-1094.96	-396.07	-357.85	-530.58	-129.68

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1094.96 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.53
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979726.60 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1188
Pez = (Area*Fy)/Lambda^2 = 1612036.29 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1094.96	-396.07	-530.58
TOTAL	-1094.96	-396.07	-530.58

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -396.07 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -530.58 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979726.5968 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.781 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8565e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979726.5968 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.03 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.57 kN.
          -. phiPn =  phi*Pn  =      20294.62 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1094.96
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.62

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{396.07}{2712.54} = 0.146 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{530.58}{3285.85} = 0.161 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.027 + [\ 0.146 + 0.161\ ]$$

$$= 0.334 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 352.70 kN.

$$\frac{Vuy}{phiVny} = \frac{352.70}{6856.22} = 0.051 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 337.84 kN.

$$\frac{Vuz}{phiVnz} = \frac{337.84}{6094.42} = 0.055 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04481e+000,  Lz   = 1.04481e+000,  Lb   = 1.04481e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1108.21	-609.98	-396.28	-896.70	-544.22
TOTAL	-1108.21	-609.98	-396.28	-896.70	-544.22

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1108.21 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2847916.26 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4685944.40 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1108.21	-396.28	-544.22
TOTAL	-1108.21	-396.28	-544.22

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -396.28 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -544.22 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 2847916.2617 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.045 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8651e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 2847916.2617 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        125.07 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
           -. phiPn =  phi*Pn  =      20424.53 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1108.21
           -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20424.53

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               396.28
           -. --------  =  ---------------  =  0.146  <  1.000  --->  O.K.
               phiMny            2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               544.22
           -. --------  =  ---------------  =  0.166  <  1.000  --->  O.K.
               phiMnz            3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.027 + [  0.146  +  0.166 ]
                      =  0.339  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 347.19 kN.

$$\frac{Vuy}{phiVny} = \frac{347.19}{8273.17} = 0.042 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 358.28 kN.

$$\frac{Vuz}{phiVnz} = \frac{358.28}{6094.42} = 0.059 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108120,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78134e+000,  Lz   = 1.78134e+000,  Lb   = 1.78134e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	1117.74	393.16	530.85
TOTAL	1117.74	393.16	530.85

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 393.16 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 530.85 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 11.5 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 21631.50 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{1117.74}{21631.50} = 0.052 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                393.16
           -. --------  =  ---------------  =  0.145  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                530.85
           -. --------  =  ---------------  =  0.162  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.026 + [  0.145  +  0.162 ]
                      =  0.332  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 385.07 kN.

$$\frac{Vuy}{phiVny} = \frac{385.07}{6856.22} = 0.056 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 244.82 kN.

$$\frac{Vuz}{phiVnz} = \frac{244.82}{6094.42} = 0.040 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108121,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04541e+000,  Lz   = 1.04541e+000,  Lb   = 1.04541e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	1131.76	393.18	540.89
TOTAL	1131.76	393.18	540.89

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 393.18 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 540.89 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 6.8 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 21631.50 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{1131.76}{21631.50} = 0.052 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{393.18}{2713.75} = 0.145 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{540.89}{3288.12} = 0.164 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.026 + [\ 0.145 + 0.164\ ]$$

$$= 0.336 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 379.76 kN.
Vuy 379.76
-. -------- = --------------- = 0.046 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 275.41 kN.
Vuz 275.41
-. -------- = --------------- = 0.045 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.17035e+000,  Lz   = 2.17035e+000,  Lb   = 2.17035e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1911.09	-691.01	-231.01	-234.54	-260.59
TOTAL	-1911.09	-691.01	-231.01	-234.54	-260.59

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1911.09 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.98
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1848
Pey = (Area*Fy)/Lambda^2 = 686220.74 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.51
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1389
Pez = (Area*Fy)/Lambda^2 = 1214380.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1911.09	-691.01	-234.54
TOTAL	-1911.09	-691.01	-234.54

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -691.01 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -234.54 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.0 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  686220.7441 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.170 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.2754e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  686220.7441 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         29.29 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23094.36 kN.
          -. phiPn =  phi*Pn  =      20784.93 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1911.09
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20784.93

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.86 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.86 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{691.01}{2819.86} = 0.245 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.35 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.35 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.35 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{234.54}{3511.35} = 0.067 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.046 + [\ 0.245 + 0.067\ ]$$

$$= 0.358 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 194.64 kN.

$$\frac{Vuy}{phiVny} = \frac{194.64}{6856.22} = 0.028 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 328.38 kN.

$$\frac{Vuz}{phiVnz} = \frac{328.38}{6094.42} = 0.054 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.60778e-001,  Lz   = 8.60778e-001,  Lb   = 8.60778e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1926.09	-725.92	-691.03	-398.39	-231.87
TOTAL	-1926.09	-725.92	-691.03	-398.39	-231.87

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1926.09 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0733
Pey = (Area*Fy)/Lambda^2 = 4362572.72 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.17
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0551
Pez = (Area*Fy)/Lambda^2 = 7720287.40 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1926.09	-691.03	-231.87
TOTAL	-1926.09	-691.03	-231.87

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -691.03 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -231.87 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4362572.7210 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.861 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.9895e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4362572.7210 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        186.22 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23374.13 kN.
          -. phiPn =  phi*Pn  =      21036.72 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1926.09
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           21036.72

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2821.98 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2821.98 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                691.03
           -. --------  =  ---------------  =  0.245  <  1.000  --->  O.K.
               phiMny             2821.98

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.72 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.72 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.72 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                231.87
           -. --------  =  ---------------  =  0.066  <  1.000  --->  O.K.
               phiMnz             3515.72

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.046 + [  0.245  +  0.066 ]
                      =  0.357  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 197.66 kN.

$$\frac{Vuy}{phiVny} = \frac{197.66}{8654.07} = 0.023 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 181.00 kN.

$$\frac{Vuz}{phiVnz} = \frac{181.00}{6094.42} = 0.030 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 108140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.23135e+000,  Lz   = 2.23135e+000,  Lb   = 2.23135e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2270.59	-682.16	-212.91	-167.67	-211.35
TOTAL	-2270.59	-682.16	-212.91	-167.67	-211.35

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2270.59 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.37
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1900
Pey = (Area*Fy)/Lambda^2 = 649218.46 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.80
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1428
Pez = (Area*Fy)/Lambda^2 = 1148898.46 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2270.59	-682.16	-167.67
TOTAL	-2270.59	-682.16	-167.67

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -682.16 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -167.67 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  649218.4573 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.231 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.9370e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  649218.4573 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          27.71 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23075.56 kN.
          -. phiPn =  phi*Pn  =      20768.01 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2270.59
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20768.01

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.76 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.76 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{682.16}{2819.76} = 0.242 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.14 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.14 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.14 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{167.67}{3511.14} = 0.048 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.055 + [\ 0.242 + 0.048\ ]$$

$$= 0.344 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 188.11 kN.

$$\text{Vuy} / \text{phiVny} = 188.11 / 6856.22 = 0.027 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = I)
-. Applied shear force : Vuz = 235.81 kN.

$$\text{Vuz} / \text{phiVnz} = 235.81 / 6094.42 = 0.039 < 1.000 \text{ ---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 108141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.49568e-001,  Lz   = 9.49568e-001,  Lb   = 9.49568e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2285.13	-720.54	-681.50	-322.64	-170.41
TOTAL	-2285.13	-720.54	-681.50	-322.64	-170.41

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2285.13 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.12
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0808
Pey = (Area*Fy)/Lambda^2 = 3584864.11 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.60
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0608
Pez = (Area*Fy)/Lambda^2 = 6344004.55 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2285.13	-681.50	-170.41
TOTAL	-2285.13	-681.50	-170.41

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -681.50 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -170.41 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3584864.1085 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.950 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.2783e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3584864.1085 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        153.02 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23362.74 kN.
          -. phiPn =  phi*Pn  =      21026.46 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2285.13
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           21026.46

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2821.83 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2821.83 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               681.50
           -. --------  =  ---------------  =  0.242  <  1.000  --->  O.K.
              phiMny             2821.83

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.43 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.43 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.43 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               170.41
           -. --------  =  ---------------  =  0.048  <  1.000  --->  O.K.
              phiMnz             3515.43

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.054 + [  0.242  +  0.048 ]
                      =  0.344  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 177.25 kN.

$$\frac{Vuy}{phiVny} = \frac{177.25}{8654.07} = 0.020 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 120.21 kN.

$$\frac{Vuz}{phiVnz} = \frac{120.21}{6094.42} = 0.020 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================

      *. PROJECT     :
      *. MEMBER NO   = 108210,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78134e+000,  Lz   = 1.78134e+000,  Lb   = 1.78134e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2120.96	-460.44	-457.52	-227.14	-79.47
TOTAL	-2120.96	-460.44	-457.52	-227.14	-79.47

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2120.96 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.53
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979726.60 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1188
Pez = (Area*Fy)/Lambda^2 = 1612036.29 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2120.96	-460.44	-227.14
TOTAL	-2120.96	-460.44	-227.14

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -460.44 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -227.14 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979726.5968 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.781 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8565e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979726.5968 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.03 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.57 kN.
          -. phiPn =  phi*Pn  =      20294.62 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2120.96
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           20294.62

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{460.44}{2712.54} = 0.170 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{227.14}{3285.85} = 0.069 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.052 + [\ 0.170 + 0.069\ ]$$

$$= 0.291 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 340.80 kN.

$$\frac{Vuy}{phiVny} = \frac{340.80}{6856.22} = 0.050 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 233.25 kN.

$$\frac{Vuz}{phiVnz} = \frac{233.25}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108211,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04481e+000,  Lz   = 1.04481e+000,  Lb   = 1.04481e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2111.96	-313.57	-460.37	-415.74	-232.87
TOTAL	-2111.96	-313.57	-460.37	-415.74	-232.87

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2111.96 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2847916.26 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4685944.40 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2111.96	-460.37	-232.87
TOTAL	-2111.96	-460.37	-232.87

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -460.37 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -232.87 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2847916.2617 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8651e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2847916.2617 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.07 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
          -. phiPn =  phi*Pn  =      20424.53 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2111.96
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           20424.53

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                460.37
           -. --------  =  ---------------  =  0.170  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                232.87
           -. --------  =  ---------------  =  0.071  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.052 + [  0.170  +  0.071 ]
                      =  0.292  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 335.47 kN.

$$\frac{Vuy}{phiVny} = \frac{335.47}{8273.17} = 0.041 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 264.28 kN.

$$\frac{Vuz}{phiVnz} = \frac{264.28}{6094.42} = 0.043 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78134e+000,  Lz   = 1.78134e+000,  Lb   = 1.78134e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1057.89	-338.64	-284.71	-471.05	-94.61
TOTAL	-1057.89	-338.64	-284.71	-471.05	-94.61

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1057.89 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.53
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979726.60 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1188
Pez = (Area*Fy)/Lambda^2 = 1612036.29 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1057.89	-338.64	-471.05
TOTAL	-1057.89	-338.64	-471.05

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -338.64 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -471.05 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979726.5968 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.781 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8565e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979726.5968 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.03 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.57 kN.
          -. phiPn =  phi*Pn  =      20294.62 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1057.89
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.62

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{338.64}{2712.54} = 0.125 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{471.05}{3285.85} = 0.143 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.026 + [\ 0.125 + 0.143\ ]$$

$$= 0.294 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 338.54 kN.

$$\frac{Vuy}{phiVny} = \frac{338.54}{6856.22} = 0.049 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 344.99 kN.

$$\frac{Vuz}{phiVnz} = \frac{344.99}{6094.42} = 0.057 < 1.000 \quad ---> \quad O.K.$$

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 108221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04541e+000,  Lz   = 1.04541e+000,  Lb   = 1.04541e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1061.23	-483.75	-338.62	-826.55	-481.55
TOTAL	-1061.23	-483.75	-338.62	-826.55	-481.55

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1061.23 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0895
Pey = (Area*Fy)/Lambda^2 = 2844661.49 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4680589.02 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1061.23	-338.62	-481.55
TOTAL	-1061.23	-338.62	-481.55

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -338.62 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -481.55 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2844661.4943 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8619e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2844661.4943 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        124.93 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.84 kN.
          -. phiPn =  phi*Pn  =      20424.46 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1061.23
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20424.46

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{338.62}{2713.75} = 0.125 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{481.55}{3288.12} = 0.146 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.026 + [\ 0.125 + 0.146\ ]$$

$$= 0.297 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 333.16 kN.

$$\frac{Vuy}{phiVny} = \frac{333.16}{8273.17} = 0.040 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 358.79 kN.

$$\frac{Vuz}{phiVnz} = \frac{358.79}{6094.42} = 0.059 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.22119e+000,  Lz   = 2.22119e+000,  Lb   = 2.22119e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	1393.92	661.92	169.75
TOTAL	1393.92	661.92	169.75

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 661.92 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 169.75 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 14.3 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 22255.39 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{1393.92}{22255.39} = 0.063 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.78 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.78 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{661.92}{2819.78} = 0.235 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.18 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.18 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.18 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{169.75}{3511.18} = 0.048 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.031 + [\ 0.235 + 0.048\ ]$$

$$= 0.314 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 159.44 kN.

$$\text{-. } \frac{\text{Vuy}}{\text{phiVny}} = \frac{159.44}{6856.22} = 0.023 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 313.21 kN.

$$\text{-. } \frac{\text{Vuz}}{\text{phiVnz}} = \frac{313.21}{6094.42} = 0.051 < 1.000 \text{ ---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 108231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.76220e-001,  Lz   = 8.76220e-001,  Lb   = 8.76220e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	1418.80	661.50	172.33
TOTAL	1418.80	661.50	172.33

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 661.50 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 172.33 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 5.6 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 22255.39 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{1418.80}{22255.39} = 0.064 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{661.50}{2821.95} = 0.234 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.67 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.67 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.67 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{172.33}{3515.67} = 0.049 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.032 + [\ 0.234 + 0.049\ ]$$

$$= 0.315 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 153.97 kN.

$$\text{-. } \frac{\text{Vuy}}{\text{phiVny}} = \frac{153.97}{8654.07} = 0.018 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 176.08 kN.

$$\text{-. } \frac{\text{Vuz}}{\text{phiVnz}} = \frac{176.08}{6094.42} = 0.029 < 1.000 \text{ ---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 108240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.28064e+000,  Lz   = 2.28064e+000,  Lb   = 2.28064e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2090.03	-660.94	-227.48	-147.27	-222.31
TOTAL	-2090.03	-660.94	-227.48	-147.27	-222.31

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2090.03 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.69
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1942
Pey = (Area*Fy)/Lambda^2 = 621458.28 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.04
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1460
Pez = (Area*Fy)/Lambda^2 = 1099772.27 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2090.03	-660.94	-147.27
TOTAL	-2090.03	-660.94	-147.27

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -660.94 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -147.27 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.7 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  621458.2792 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.281 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.6832e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  621458.2792 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          26.53 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23060.00 kN.
          -. phiPn =  phi*Pn  =      20754.00 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2090.03
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           20754.00

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.68 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.68 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{660.94}{2819.68} = 0.234 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3510.98 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3510.98 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3510.98 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{147.27}{3510.98} = 0.042 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.050 + [\ 0.234 + 0.042\ ]$$

$$= 0.327 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 154.97 kN.

$$\frac{Vuy}{phiVny} = \frac{154.97}{6856.22} = 0.023 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = I)
-. Applied shear force : Vuz = 220.74 kN.

$$\frac{Vuz}{phiVnz} = \frac{220.74}{6094.42} = 0.036 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 108241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.66667e-001,  Lz   = 9.66667e-001,  Lb   = 9.66667e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2102.98	-701.35	-661.14	-244.74	-151.21
TOTAL	-2102.98	-701.35	-661.14	-244.74	-151.21

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2102.98 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.23
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0823
Pey = (Area*Fy)/Lambda^2 = 3459165.89 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.68
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0619
Pez = (Area*Fy)/Lambda^2 = 6121560.95 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2102.98	-661.14	-151.21
TOTAL	-2102.98	-661.14	-151.21

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -661.14 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -151.21 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.2 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3459165.8892 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.967 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.1634e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3459165.8892 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        147.66 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23360.41 kN.
          -. phiPn =  phi*Pn  =      21024.37 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2102.98
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           21024.37

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2821.80 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2821.80 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               661.14
           -. --------  =  ---------------  =  0.234  <  1.000  --->  O.K.
               phiMny            2821.80

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.37 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.37 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.37 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               151.21
           -. --------  =  ---------------  =  0.043  <  1.000  --->  O.K.
               phiMnz            3515.37

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.050 + [  0.234  +  0.043 ]
                      =  0.327  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 154.78 kN.

$$\frac{Vuy}{phiVny} = \frac{154.78}{8654.07} = 0.018 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 114.62 kN.

$$\frac{Vuz}{phiVnz} = \frac{114.62}{6094.42} = 0.019 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 109003,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =    35
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_R_Sup_c_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.634,  Flg Width   =      1.330,  Web Center  =      1.292
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.634,  Flg Width   =      1.330,  Web Center  =      1.292
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.621,  Flg Width   =      1.430,  Web Center  =      1.392
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 1.43850e-001,  Asy  = 1.01346e-001,  Asz  = 4.83108e-002
         Ybar = 6.65000e-001,  Zbar = 3.17000e-001,  Qyb  = 2.37029e-001,  Qzb  = 4.01268e-001
         Syy  = 3.18967e-002,  Szz  = 4.91419e-002,  Zyy  = 3.61233e-002,  Zzz  = 6.11532e-002
         Iyy  = 1.01112e-002,  Izz  = 3.26794e-002,  Iyz  = 0.00000e+000
         ry   = 2.65123e-001,  rz   = 4.76630e-001
        <Pos I>.
         Area = 1.43850e-001,  Asy  = 1.01346e-001,  Asz  = 4.83108e-002
         Ybar = 6.65000e-001,  Zbar = 3.17000e-001,  Qyb  = 2.37029e-001,  Qzb  = 4.01268e-001
         Syy  = 3.18967e-002,  Szz  = 4.91419e-002,  Zyy  = 3.61233e-002,  Zzz  = 6.11532e-002
         Iyy  = 1.01112e-002,  Izz  = 3.26794e-002,  Iyz  = 0.00000e+000
         ry   = 2.65123e-001,  rz   = 4.76630e-001
        <Pos J>.
         Area = 1.50480e-001,  Asy  = 1.08966e-001,  Asz  = 4.73202e-002
         Ybar = 7.15000e-001,  Zbar = 3.10500e-001,  Qyb  = 2.45488e-001,  Qzb  = 4.45189e-001
         Syy  = 3.31591e-002,  Szz  = 5.40990e-002,  Zyy  = 3.74123e-002,  Zzz  = 6.78468e-002
         Iyy  = 1.02959e-002,  Izz  = 3.86808e-002,  Iyz  = 0.00000e+000
         ry   = 2.61573e-001,  rz   = 5.07001e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.72000e-001,  Lz   = 1.72000e-001,  Lb   = 1.72000e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	650.25	1076.91	1220.26
TOTAL	650.25	1076.91	1220.26

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 1076.91 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 1220.26 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 0.6 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 47111.15 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{650.25}{47111.15} = 0.014 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =      10995.52 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =      10995.52 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy              1076.91
           -. --------  =  ---------------  =  0.098  <  1.000  --->  O.K.
               phiMny           10995.52

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =      16939.10 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =      16939.10 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =      16939.10 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz              1220.26
           -. --------  =  ---------------  =  0.072  <  1.000  --->  O.K.
               phiMnz           16939.10

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.007 + [  0.098  +  0.072 ]
                      =  0.177  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 20263.93 kN.
-. Vny = C*Vp = 20263.93 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuy = 1115.13 kN.

$$\text{Vuy} / \text{phiVny} = 1115.13 / 20263.93 = 0.055 < 1.000 \quad \text{---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 9461.58 kN.
-. Vnz = C*Vp = 9461.58 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 698.32 kN.

$$\text{Vuz} / \text{phiVnz} = 698.32 / 9461.58 = 0.074 < 1.000 \quad \text{---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 109010,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78205e+000,  Lz   = 1.78205e+000,  Lb   = 1.78205e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1940.16	-218.67	-459.12	-329.67	-479.58
TOTAL	-1940.16	-218.67	-459.12	-329.67	-479.58

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1940.16 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834232.82 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1011762.33 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1940.16	-459.12	-479.58
TOTAL	-1940.16	-459.12	-479.58

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -459.12 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -479.58 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  834232.8212 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2334e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834232.8212 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.04 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.73 kN.
          -. phiPn =  phi*Pn  =      18108.66 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1940.16
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn            18108.66

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{459.12}{2310.95} = 0.199 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2490.69 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2490.69 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2490.69 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{479.58}{2490.69} = 0.193 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.054 + [\ 0.199 + 0.193\ ]$$

$$= 0.445 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 107.76 kN.

$$\frac{Vuy}{phiVny} = \frac{107.76}{6856.22} = 0.016 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 268.42 kN.

$$\frac{Vuz}{phiVnz} = \frac{268.42}{6094.42} = 0.044 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 109011,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04452e+000,  Lz   = 1.04452e+000,  Lb   = 1.04452e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1914.93	-328.92	-218.54	-291.30	-350.56
TOTAL	-1914.93	-328.92	-218.54	-291.30	-350.56

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1914.93 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2849466.78 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4688495.61 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1914.93	-218.54	-350.56
TOTAL	-1914.93	-218.54	-350.56

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -218.54 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -350.56 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2849466.7802 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8667e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2849466.7802 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.14 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.97 kN.
          -. phiPn =  phi*Pn  =      20424.57 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1914.93
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20424.57

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{218.54}{2713.75} = 0.081 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{350.56}{3288.12} = 0.107 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.047 + [\ 0.081 + 0.107\ ]$$

$$= 0.234 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 110.14 kN.

$$\frac{Vuy}{phiVny} = \frac{110.14}{8273.17} = 0.013 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 423.80 kN.

$$\frac{Vuz}{phiVnz} = \frac{423.80}{6094.42} = 0.070 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 109020,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78138e+000,  Lz   = 1.78138e+000,  Lb   = 1.78138e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1761.62	-308.01	-359.80	-395.01	-516.43
TOTAL	-1761.62	-308.01	-359.80	-395.01	-516.43

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1761.62 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1560
Pey = (Area*Fy)/Lambda^2 = 834859.82 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1012522.75 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1761.62	-359.80	-516.43
TOTAL	-1761.62	-359.80	-516.43

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -359.80 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -516.43 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  834859.8168 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.781 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2343e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834859.8168 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         41.07 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.88 kN.
          -. phiPn =  phi*Pn  =      18108.79 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1761.62
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           18108.79

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{359.80}{2310.95} = 0.156 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2490.70 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2490.70 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2490.70 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{516.43}{2490.70} = 0.207 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.049 + [\ 0.156 + 0.207\ ]$$

$$= 0.412 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 96.45 kN.

$$\frac{Vuy}{phiVny} = \frac{96.45}{6856.22} = 0.014 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 248.68 kN.

$$\frac{Vuz}{phiVnz} = \frac{248.68}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 109021,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04531e+000,  Lz   = 1.04531e+000,  Lb   = 1.04531e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1748.80	-225.73	-307.93	-352.75	-419.20
TOTAL	-1748.80	-225.73	-307.93	-352.75	-419.20

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1748.80 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0895
Pey = (Area*Fy)/Lambda^2 = 2845163.95 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4681415.75 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1748.80	-307.93	-419.20
TOTAL	-1748.80	-307.93	-419.20

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -307.93 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -419.20 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 2845163.9466 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.045 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8624e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 2845163.9466 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        124.95 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22693.85 kN.
           -. phiPn =  phi*Pn  =      20424.47 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1748.80
           -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20424.47

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                307.93
           -. --------  =  ---------------  =  0.113  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                419.20
           -. --------  =  ---------------  =  0.127  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.043 + [  0.113  +  0.127 ]
                      =  0.284  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 101.28 kN.

$$\frac{Vuy}{phiVny} = \frac{101.28}{8273.17} = 0.012 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 368.87 kN.

$$\frac{Vuz}{phiVnz} = \frac{368.87}{6094.42} = 0.061 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 109030,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =    73
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Vert_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.621,  Flg Width   =      0.621,  Web Center  =      0.583
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001
        <Pos I>.
         Area = 8.88340e-002,  Asy  = 4.73202e-002,  Asz  = 4.73202e-002
         Ybar = 3.10500e-001,  Zbar = 3.10500e-001,  Qyb  = 1.27596e-001,  Qzb  = 1.27596e-001
         Syy  = 1.62707e-002,  Szz  = 1.62707e-002,  Zyy  = 1.94456e-002,  Zzz  = 1.94456e-002
         Iyy  = 5.05205e-003,  Izz  = 5.05205e-003,  Iyz  = 0.00000e+000
         ry   = 2.38476e-001,  rz   = 2.38476e-001
        <Pos J>.
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.27800e+000,  Lz   = 2.27800e+000,  Lb   = 2.27800e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	247.03	1665.14	104.45
TOTAL	247.03	1665.14	104.45

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 1665.14 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 104.45 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 13.5 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 20558.41 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{247.03}{20558.41} = 0.012 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2738.15 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2738.15 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{1665.14}{2738.15} = 0.608 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2738.15 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2738.15 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2738.15 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{104.45}{2738.15} = 0.038 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.006 + [\ 0.608 + 0.038\ ]$$

$$= 0.652 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 356.89 kN.

$$\text{Vuy} / \text{phiVny} = 356.89 / 6856.22 = 0.052 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6856.22 kN.
-. Vnz = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 524.95 kN.

$$\text{Vuz} / \text{phiVnz} = 524.95 / 6856.22 = 0.077 < 1.000 \text{ ---> O.K.}$$

5.2. CALZADA PEATONAL TRAMO 2

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
==========================================================================================


        +============================================================+
        |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
        |  MIDAS/Civil - Design & checking system for windows        |
        +============================================================+
        |  Steel Member Applicable Code Checking                     |
        |  Based On  AASHTO-LRFD16, AASHTO-LRFD12, AASHTO-LRFD02,    |
        |            AASHTO-LFD96, AASHTO-ASD96, AISC-LRFD2K,        |
        |            AISC-LRFD93, AISC-ASD89, Eurocode3-2:05,        |
        |            BS5950-90, IS:800-2007, IS:800-1984,            |
        |            IRC:24-2010, CSA-S6-14                          |
        |                                                            |
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        |                                                            |
        |                                                            |
        |                                          (c)SINCE 1989     |
        +============================================================+
        |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)  |
        |  MIDAS IT Design Development Team                          |
        +============================================================+
        |            HomePage : www.MidasUser.com                    |
        +============================================================+
        |  MIDAS/Civil  Version 8.8.5                                |
        +============================================================+


    *. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
------------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
------------------------------------------------------------------------------------------
     65+  1       PL01d-ext_( 4.300) +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300)
               +    PL01i-int_( 4.300) +     PL02d-ext( 4.300) +    PL02i-ext_( 4.300)
               +    PL02d-int_( 4.300) +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300)
               +    PL03i-ext_( 4.300) +    PL03d-int_( 4.300) +    PL03i-int_( 4.300)
               +    PL04d-ext_( 4.300) +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300)
               +    PL04i-int_( 4.300) +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300)
               +    PL05d-int_( 4.300) +    PL05i-ext_( 4.300) +    PL06d-ext_( 4.300)
               +    PL06i-ext_( 4.300) +    PL06d-int_( 4.300) +    PL06i-int_( 4.300)
               +    PL07d-ext_( 4.300) +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300)
               +    PL07i-int_( 4.300) +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300)
               +    PL08d-int_( 4.300) +    PL08i-ext_( 4.300) +    PL09d-ext_( 4.300)
               +    PL09i-ext_( 4.300) +    PL09d-int_( 4.300) +    PL09i-int_( 4.300)
               +    PL10d-ext_( 4.300) +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300)
               +    PL10i-int_( 4.300)
     65-  1       PL01d-ext_( 4.300) +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300)
               +    PL01i-int_( 4.300) +     PL02d-ext( 4.300) +    PL02i-ext_( 4.300)
               +    PL02d-int_( 4.300) +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300)
               +    PL03i-ext_( 4.300) +    PL03d-int_( 4.300) +    PL03i-int_( 4.300)
               +    PL04d-ext_( 4.300) +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300)
               +    PL04i-int_( 4.300) +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300)
               +    PL05d-int_( 4.300) +    PL05i-ext_( 4.300) +    PL06d-ext_( 4.300)
               +    PL06i-ext_( 4.300) +    PL06d-int_( 4.300) +    PL06i-int_( 4.300)
               +    PL07d-ext_( 4.300) +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300)
               +    PL07i-int_( 4.300) +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300)
```

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                +    PL08d-int_( 4.300) +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300)
                +    PL09i-ext_( 4.300) +    PL09d-int_( 4.300) +    PL09i-int_( 4.300)
                +    PL10d-ext_( 4.300) +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300)
                +    PL10i-int_( 4.300)
     66+  1       PL01d-ext_( 7.190) +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190)
                +    PL01i-int_( 7.190) +     PL02d-ext( 7.190) +    PL02i-ext_( 7.190)
                +    PL02d-int_( 7.190) +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190)
                +    PL03i-ext_( 7.190) +    PL03d-int_( 7.190) +    PL03i-int_( 7.190)
                +    PL04d-ext_( 7.190) +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190)
                +    PL04i-int_( 7.190) +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190)
                +    PL05d-int_( 7.190) +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190)
                +    PL06i-ext_( 7.190) +    PL06d-int_( 7.190) +    PL06i-int_( 7.190)
                +    PL07d-ext_( 7.190) +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190)
                +    PL07i-int_( 7.190) +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190)
                +    PL08d-int_( 7.190) +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190)
                +    PL09i-ext_( 7.190) +    PL09d-int_( 7.190) +    PL09i-int_( 7.190)
                +    PL10d-ext_( 7.190) +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190)
                +    PL10i-int_( 7.190)
     66-  1       PL01d-ext_( 7.190) +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190)
                +    PL01i-int_( 7.190) +     PL02d-ext( 7.190) +    PL02i-ext_( 7.190)
                +    PL02d-int_( 7.190) +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190)
                +    PL03i-ext_( 7.190) +    PL03d-int_( 7.190) +    PL03i-int_( 7.190)
                +    PL04d-ext_( 7.190) +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190)
                +    PL04i-int_( 7.190) +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190)
                +    PL05d-int_( 7.190) +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190)
                +    PL06i-ext_( 7.190) +    PL06d-int_( 7.190) +    PL06i-int_( 7.190)
                +    PL07d-ext_( 7.190) +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190)
                +    PL07i-int_( 7.190) +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190)
                +    PL08d-int_( 7.190) +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190)
                +    PL09i-ext_( 7.190) +    PL09d-int_( 7.190) +    PL09i-int_( 7.190)
                +    PL10d-ext_( 7.190) +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190)
                +    PL10i-int_( 7.190)
    148+  1      DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.525)
                +    PL01i-ext_( 7.525) +    PL01d-int_( 7.525) +    PL01i-int_( 7.525)
                +     PL02d-ext( 7.525) +    PL02i-ext_( 7.525) +    PL02d-int_( 7.525)
                +    PL02i-int_( 7.525) +    PL03d-ext_( 7.525) +    PL03i-ext_( 7.525)
                +    PL03d-int_( 7.525) +    PL03i-int_( 7.525) +    PL04d-ext_( 7.525)
                +    PL04i-ext_( 7.525) +    PL04d-int_( 7.525) +    PL04i-int_( 7.525)
                +    PL05d-ext_( 7.525) +    PL05i-ext_( 7.525) +    PL05d-int_( 7.525)
                +    PL05i-int_( 7.525) +    PL06d-ext_( 7.525) +    PL06i-ext_( 7.525)
                +    PL06d-int_( 7.525) +    PL06i-ext_( 7.525) +    PL07d-ext_( 7.525)
                +    PL07i-ext_( 7.525) +    PL07d-int_( 7.525) +    PL07i-int_( 7.525)
                +    PL08d-ext_( 7.525) +    PL08i-ext_( 7.525) +    PL08d-int_( 7.525)
                +    PL08i-int_( 7.525) +    PL09d-ext_( 7.525) +    PL09i-ext_( 7.525)
                +    PL09d-int_( 7.525) +    PL09i-int_( 7.525) +    PL10d-ext_( 7.525)
                +    PL10i-ext_( 7.525) +    PL10d-int_( 7.525) +    PL10i-int_( 7.525)
                +        TU_ENV( 1.200) +        TG_ENV( 0.500) +        SE01a_( 1.000)
                +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
                +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
                +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
                +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
                +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
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                +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
                +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
    148-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.525)
                +    PL01i-ext_( 7.525) +    PL01d-int_( 7.525) +    PL01i-int_( 7.525)
                +     PL02d-ext( 7.525) +    PL02i-ext_( 7.525) +    PL02d-int_( 7.525)
                +    PL02i-int_( 7.525) +    PL03d-ext_( 7.525) +    PL03i-ext_( 7.525)
                +    PL03d-int_( 7.525) +    PL03i-int_( 7.525) +    PL04d-ext_( 7.525)
                +    PL04i-ext_( 7.525) +    PL04d-int_( 7.525) +    PL04i-int_( 7.525)
                +    PL05d-ext_( 7.525) +    PL05i-ext_( 7.525) +    PL05d-int_( 7.525)
                +    PL05i-int_( 7.525) +    PL06d-ext_( 7.525) +    PL06i-ext_( 7.525)
                +    PL06d-int_( 7.525) +    PL06i-int_( 7.525) +    PL07d-ext_( 7.525)
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                +    PL08d-ext_( 7.525) +    PL08i-ext_( 7.525) +    PL08d-int_( 7.525)
                +    PL08i-int_( 7.525) +    PL09d-ext_( 7.525) +    PL09i-ext_( 7.525)
                +    PL09d-int_( 7.525) +    PL09i-int_( 7.525) +    PL10d-ext_( 7.525)
                +    PL10i-ext_( 7.525) +    PL10d-int_( 7.525) +    PL10i-int_( 7.525)
                +        TU_ENV( 1.200) +        TG_ENV( 0.500) +        SE01a_( 1.000)
                +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
                +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
                +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
                +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
                +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
                +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
                +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
    149+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +        TU_ENV( 1.200)
                +        WS_ENV( 1.400) +        TG_ENV( 0.500) +        SE01a_( 1.000)
                +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
                +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
                +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
                +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
                +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
                +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
                +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
    149-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +        TU_ENV( 1.200)
                +        WS_ENV( 1.400) +        TG_ENV( 0.500) +        SE01a_( 1.000)
                +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
                +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
                +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
                +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
                +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
                +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
                +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
    151+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
                +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
                +     PL02d-ext( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
                +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
                +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
                +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
                +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
                +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
                +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
                +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
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                +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
                +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
                +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
                +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
                +EQ_1.0X/0.3Y_ENV( 1.000)
    151-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
                +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
                +     PL02d-ext( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
                +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
                +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
                +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
                +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
                +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
                +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
                +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
                +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
                +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
                +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
                +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
                +EQ_1.0X/0.3Y_ENV( 1.000)
    152+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
                +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
                +     PL02d-ext( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
                +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
                +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
                +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
                +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
                +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
                +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
                +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
                +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
                +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
                +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
                +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
                +EQ_0.3X/1.0Y_ENV( 1.000)
    152-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
                +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
                +     PL02d-ext( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
                +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
                +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
                +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
                +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
                +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
                +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
                +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
                +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
                +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
                +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
                +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
                +EQ_0.3X/1.0Y_ENV( 1.000)
    153+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
                +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
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                +     PL02d-ext( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
                +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
                +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
                +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
                +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
                +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
                +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
                +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
                +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
                +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
                +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
                +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
    153-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
                +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
                +     PL02d-ext( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
                +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
                +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
                +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
                +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
                +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
                +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
                +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
                +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
                +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
                +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
                +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
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      *. PROJECT     :
      *. MEMBER NO   = 101003,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    35
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_R_Sup_c_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.621,  Flg Width   =      1.430,  Web Center  =      1.392
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.634,  Flg Width   =      1.330,  Web Center  =      1.292
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.621,  Flg Width   =      1.430,  Web Center  =      1.392
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.50480e-001,  Asy  = 1.08966e-001,  Asz  = 4.73202e-002
         Ybar = 7.15000e-001,  Zbar = 3.10500e-001,  Qyb  = 2.45488e-001,  Qzb  = 4.45189e-001
         Syy  = 3.31591e-002,  Szz  = 5.40990e-002,  Zyy  = 3.74123e-002,  Zzz  = 6.78468e-002
         Iyy  = 1.02959e-002,  Izz  = 3.86808e-002,  Iyz  = 0.00000e+000
         ry   = 2.61573e-001,  rz   = 5.07001e-001
        <Pos I>.
         Area = 1.43850e-001,  Asy  = 1.01346e-001,  Asz  = 4.83108e-002
         Ybar = 6.65000e-001,  Zbar = 3.17000e-001,  Qyb  = 2.37029e-001,  Qzb  = 4.01268e-001
         Syy  = 3.18967e-002,  Szz  = 4.91419e-002,  Zyy  = 3.61233e-002,  Zzz  = 6.11532e-002
         Iyy  = 1.01112e-002,  Izz  = 3.26794e-002,  Iyz  = 0.00000e+000
         ry   = 2.65123e-001,  rz   = 4.76630e-001
        <Pos J>.
         Area = 1.50480e-001,  Asy  = 1.08966e-001,  Asz  = 4.73202e-002
         Ybar = 7.15000e-001,  Zbar = 3.10500e-001,  Qyb  = 2.45488e-001,  Qzb  = 4.45189e-001
         Syy  = 3.31591e-002,  Szz  = 5.40990e-002,  Zyy  = 3.74123e-002,  Zzz  = 6.78468e-002
         Iyy  = 1.02959e-002,  Izz  = 3.86808e-002,  Iyz  = 0.00000e+000
         ry   = 2.61573e-001,  rz   = 5.07001e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.72000e-001,  Lz   = 1.72000e-001,  Lb   = 1.72000e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2754.28	-1201.58	-1356.82	-891.49	-834.27
TOTAL	-2754.28	-1201.58	-1356.82	-891.49	-834.27

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2754.28 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 0.66
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0087
Pey = (Area*Fy)/Lambda^2 =686789804.23 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 0.34
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0045
Pez = (Area*Fy)/Lambda^2 = 2.58e+009 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2754.28	-1356.82	-834.27
TOTAL	-2754.28	-1356.82	-834.27

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      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =    -1356.82 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =     -834.27 kN-m.

================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AASHTO-LRFD12 Specification 6.9.3 ]
           -. Kl/r  =     0.7  <   120.0  --->  O.K.

      --------------------------------------------------------------------------
      [*]  Calculate Qa about y-axis (Sqaure and rectangular section).
      --------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  Cw - tw   =    1.35 m.
           -. DTRf  =  Dflg/tf   =   35.53  >  Lambda_r  --->  SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
           -. Dweb  =  H-tf1-tf2 =    0.54 m.
           -. DTRw  =  Dweb/tw   =   14.30  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate effective depth of stiffened flange (Bef).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Bef1  =  (1.40*tw)/SQRT[Es/f]  =   1.285 m.
                        1.92*tw     [           0.38        ]
           -. Bef2  =  ---------- * [ 1 - ----------------- ]  =   1.308 m.
                      SQRT[f/Es]    [     (DTRf)*SQRT[f/Es] ]
           -. Bef   =  MAX(Bef1,Bef2)  =   1.308 m.

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.147 m^2.
           -. Qa1 =  A_eff/Area  =   0.977  (about y-axis).

      --------------------------------------------------------------------------
      [*]  Calculate Qa about z-axis (Sqaure and rectangular section).
      --------------------------------------------------------------------------
```

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.54 m.
-. DTRf = Dflg/tw = 14.30 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = Cw - tw = 1.35 m.
-. DTRw = Dweb/tf = 35.53 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.150 m^2.
-. Qa2 = A_eff/Area = 1.000 (about z-axis).

( ). Define reduction factor of stiffened elements (Qa).
-. Qa = MIN[Qa1, Qa2] = 0.977

( ). Full reduction factor for slender section (QsQa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Q = Qs*Qa = 0.977

-. Po = Q*Fy*Area = 50672.7608 kN.

( ). Calculate Flexural Buckling Resistance (Pe_FB).
[AASHTO-LRFD12 Specification 6.9.4.1]

$$Pe\_FB = \frac{pi^2 * E}{(Kl/r)^2} Area = 6.8679e+008 \text{ kN.}$$

( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
[AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1)]
-. Doubly symmetric shape
-. Gs = 7.6903e+007 KPa.
-. Kx = 1.00 (Conservatively taken value).
-. L = 0.172 m.
-. Pe_FTB = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz) = 2.0495e+039 kN.

( ). Elastic Critical Buckling Resistance (Pe).
-. Pe = min[Pe_FB, Pe_FTB] = 6.8679e+008 kN.

( ). Calculate axial compressive strength (phiPn).
[AASHTO-LRFD12 Specification 6.9.4.1.1]
-. phi = 0.90
-. Pe/Po = 13553.43 >= 0.44
-. Pn = [0.658^(Po/Pe)]*Po = 50671.20 kN.
-. phiPn = phi*Pn = 45604.08 kN.

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      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              2754.28
           -. -------  =  ---------------  =          0.06  <  1.000  --->  O.K.
               phiPn           45604.08

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =      11430.74 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =      11430.74 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy             1356.82
           -. --------  =  ---------------  =  0.119  <  1.000  --->  O.K.
               phiMny           11430.74

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =      18647.65 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =      18647.65 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =      18647.65 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz              834.27
           -. --------  =  ---------------  =  0.045  <  1.000  --->  O.K.
               phiMnz           18647.65

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
```

```
                          Pu       [    Muy        Muz    ]
        -. ComRat  =  --------- + [ -------- + -------- ]
                       2*phiPn     [  phiMny     phiMnz   ]
                   =  0.030 + [  0.119  +  0.045 ]
                   =  0.194  <  1.000  --->  O.K.
```

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 20263.93 kN.
-. Vny = C*Vp = 20263.93 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuy = 636.16 kN.

$$\text{Vuy} / \text{phiVny} = 636.16 / 20263.93 = 0.031 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 9461.58 kN.
-. Vnz = C*Vp = 9461.58 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 903.01 kN.

$$\text{Vuz} / \text{phiVnz} = 903.01 / 9461.58 = 0.095 < 1.000 \text{ ---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 101010,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78221e+000,  Lz   = 1.78221e+000,  Lb   = 1.78221e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2218.50	-256.38	-485.30	-469.68	-652.29
TOTAL	-2218.50	-256.38	-485.30	-469.68	-652.29

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2218.50 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834081.80 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.73
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1418
Pez = (Area*Fy)/Lambda^2 = 1011579.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2218.50	-485.30	-652.29
TOTAL	-2218.50	-485.30	-652.29

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -485.30 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -652.29 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  834081.7996 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2332e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834081.7996 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.03 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.69 kN.
          -. phiPn =  phi*Pn  =      18108.62 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2218.50
          -. -------  =  ---------------  =          0.12  <  1.000  --->  O.K.
              phiPn           18108.62

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2310.95 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2310.95 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                485.30
           -. --------  =  ---------------  =  0.210  <  1.000  --->  O.K.
               phiMny             2310.95

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       2490.69 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       2490.69 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       2490.69 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                652.29
           -. --------  =  ---------------  =  0.262  <  1.000  --->  O.K.
               phiMnz             2490.69

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.061 + [  0.210  +  0.262 ]
                      =  0.533  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 122.50 kN.
-. Vuy / phiVny = 122.50 / 6856.22 = 0.018 < 1.000 ---> O.K.

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 207.49 kN.
-. Vuz / phiVnz = 207.49 / 6094.42 = 0.034 < 1.000 ---> O.K.

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 101011,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04472e+000,  Lz   = 1.04472e+000,  Lb   = 1.04472e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2194.65	-260.10	-256.14	-400.69	-500.56
TOTAL	-2194.65	-260.10	-256.14	-400.69	-500.56

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2194.65 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848414.64 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686764.43 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2194.65	-256.14	-500.56
TOTAL	-2194.65	-256.14	-500.56

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -256.14 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -500.56 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 2848414.6450 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.045 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8656e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 2848414.6450 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        125.10 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22693.94 kN.
           -. phiPn =  phi*Pn  =      20424.55 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              2194.65
           -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
               phiPn           20424.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{256.14}{2713.75} = 0.094 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{500.56}{3288.12} = 0.152 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.054 + [\ 0.094 + 0.152\ ]$$

$$= 0.300 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 127.67 kN.

$$\frac{Vuy}{phiVny} = \frac{127.67}{8273.17} = 0.015 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 421.17 kN.

$$\frac{Vuz}{phiVnz} = \frac{421.17}{6094.42} = 0.069 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 101020,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78221e+000,  Lz   = 1.78221e+000,  Lb   = 1.78221e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2127.58	-314.16	-425.33	-381.02	-588.67
TOTAL	-2127.58	-314.16	-425.33	-381.02	-588.67

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2127.58 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834081.80 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.73
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1418
Pez = (Area*Fy)/Lambda^2 = 1011579.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2127.58	-425.33	-588.67
TOTAL	-2127.58	-425.33	-588.67

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -425.33 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -588.67 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  834081.7996 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2332e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834081.7996 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.03 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.69 kN.
          -. phiPn =  phi*Pn  =      18108.62 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2127.58
          -. -------  =  ---------------  =          0.12  <  1.000  --->  O.K.
              phiPn           18108.62

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2310.95 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2310.95 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               425.33
           -. --------  =  ---------------  =  0.184  <  1.000  --->  O.K.
               phiMny            2310.95

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       2490.69 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       2490.69 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       2490.69 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               588.67
           -. --------  =  ---------------  =  0.236  <  1.000  --->  O.K.
               phiMnz            2490.69

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.059 + [  0.184  +  0.236 ]
                      =  0.479  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 136.61 kN.

$$\frac{Vuy}{phiVny} = \frac{136.61}{6856.22} = 0.020 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 192.23 kN.

$$\frac{Vuz}{phiVnz} = \frac{192.23}{6094.42} = 0.032 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 101021,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04472e+000,  Lz   = 1.04472e+000,  Lb   = 1.04472e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2111.81	-154.93	-314.40	-298.59	-408.87
TOTAL	-2111.81	-154.93	-314.40	-298.59	-408.87

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2111.81 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848414.64 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686764.43 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2111.81	-314.40	-408.87
TOTAL	-2111.81	-314.40	-408.87

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -314.40 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -408.87 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848414.6450 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8656e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848414.6450 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.10 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.94 kN.
          -. phiPn =  phi*Pn  =      20424.55 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2111.81
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           20424.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{314.40}{2713.75} = 0.116 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{408.87}{3288.12} = 0.124 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.052 + [\ 0.116 + 0.124\ ]$$

$$= 0.292 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 140.96 kN.

$$\frac{Vuy}{phiVny} = \frac{140.96}{8273.17} = 0.017 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 344.58 kN.

$$\frac{Vuz}{phiVnz} = \frac{344.58}{6094.42} = 0.057 < 1.000 \quad ---> \quad O.K.$$

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 101030,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    73
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Vert_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.621,  Flg Width   =      0.621,  Web Center  =      0.583
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.450,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001
        <Pos I>.
         Area = 8.88340e-002,  Asy  = 4.73202e-002,  Asz  = 4.73202e-002
         Ybar = 3.10500e-001,  Zbar = 3.10500e-001,  Qyb  = 1.27596e-001,  Qzb  = 1.27596e-001
         Syy  = 1.62707e-002,  Szz  = 1.62707e-002,  Zyy  = 1.94456e-002,  Zzz  = 1.94456e-002
         Iyy  = 5.05205e-003,  Izz  = 5.05205e-003,  Iyz  = 0.00000e+000
         ry   = 2.38476e-001,  rz   = 2.38476e-001
        <Pos J>.
         Area = 6.27736e-002,  Asy  = 3.42900e-002,  Asz  = 3.42900e-002
         Ybar = 2.25000e-001,  Zbar = 2.25000e-001,  Qyb  = 6.38046e-002,  Qzb  = 6.38046e-002
         Syy  = 7.95658e-003,  Szz  = 7.95658e-003,  Zyy  = 9.72381e-003,  Zzz  = 9.72381e-003
         Iyy  = 1.79023e-003,  Izz  = 1.79023e-003,  Iyz  = 0.00000e+000
         ry   = 1.68875e-001,  rz   = 1.68875e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.27800e+000,  Lz   = 2.27800e+000,  Lb   = 2.27800e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-767.18	-535.22	-2036.34	-314.88	-77.72
TOTAL	-767.18	-535.22	-2036.34	-314.88	-77.72

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 767.18 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.49
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1783
Pey = (Area*Fy)/Lambda^2 = 680798.35 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 13.49
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1783
Pez = (Area*Fy)/Lambda^2 = 680798.35 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-767.18	-2036.34	-77.72
TOTAL	-767.18	-2036.34	-77.72

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -2036.34 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -77.72 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 13.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.37 m.
-. DTRw = Dweb/tw = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.063 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.37 m.
-. DTRf = Dflg/tw = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.063 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  21640.4298 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  680798.3498 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.278 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.6673e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  680798.3498 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         31.46 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       21354.42 kN.
          -. phiPn =  phi*Pn  =      19218.98 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              767.18
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           19218.98

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2738.15 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2738.15 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{2036.34}{2738.15} = 0.744 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2738.15 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2738.15 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2738.15 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{77.72}{2738.15} = 0.028 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.020 + [\ 0.744 + 0.028\ ]$$

$$= 0.792 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 258.89 kN.

$$\text{Vuy} / \text{phiVny} = 258.89 / 6856.22 = 0.038 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6856.22 kN.
-. Vnz = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 659.07 kN.

$$\text{Vuz} / \text{phiVnz} = 659.07 / 6856.22 = 0.096 < 1.000 \text{ ---> O.K.}$$

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------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78195e+000,  Lz   = 1.78195e+000,  Lb   = 1.78195e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1118.59	-401.41	-327.55	-556.44	-80.10
TOTAL	-1118.59	-401.41	-327.55	-556.44	-80.10

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1118.59 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979056.45 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610933.63 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1118.59	-401.41	-556.44
TOTAL	-1118.59	-401.41	-556.44

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -401.41 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -556.44 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  979056.4466 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8497e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979056.4466 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.42 kN.
          -. phiPn =  phi*Pn  =      20294.48 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1118.59
          -. -------  =  ---------------  =          0.06  <  1.000  --->  O.K.
              phiPn           20294.48

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{401.41}{2712.54} = 0.148 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{556.44}{3285.85} = 0.169 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.028 + [\ 0.148 + 0.169\ ]$$

$$= 0.345 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 365.79 kN.

$$\frac{Vuy}{phiVny} = \frac{365.79}{6856.22} = 0.053 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = I)
-. Applied shear force : Vuz = 306.98 kN.

$$\frac{Vuz}{phiVnz} = \frac{306.98}{6094.42} = 0.050 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 102111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04468e+000,  Lz   = 1.04468e+000,  Lb   = 1.04468e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1138.99	-597.64	-402.12	-942.16	-570.14
TOTAL	-1138.99	-597.64	-402.12	-942.16	-570.14

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1138.99 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848633.88 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4687125.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1138.99	-402.12	-570.14
TOTAL	-1138.99	-402.12	-570.14

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -402.12 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -570.14 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848633.8845 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8658e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848633.8845 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.10 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.95 kN.
          -. phiPn =  phi*Pn  =      20424.55 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1138.99
          -. -------  =  ---------------  =          0.06  <  1.000  --->  O.K.
              phiPn           20424.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{402.12}{2713.75} = 0.148 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{570.14}{3288.12} = 0.173 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.028 + [\ 0.148 + 0.173\ ]$$

$$= 0.349 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 361.31 kN.

$$\frac{Vuy}{phiVny} = \frac{361.31}{8273.17} = 0.044 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 299.98 kN.

$$\frac{Vuz}{phiVnz} = \frac{299.98}{6094.42} = 0.049 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102120,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78195e+000,  Lz   = 1.78195e+000,  Lb   = 1.78195e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1615.17	-353.69	-265.93	-572.19	-150.02
TOTAL	-1615.17	-353.69	-265.93	-572.19	-150.02

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1615.17 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979056.45 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610933.63 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1615.17	-353.69	-572.19
TOTAL	-1615.17	-353.69	-572.19

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -353.69 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -572.19 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979056.4466 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8497e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979056.4466 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.42 kN.
          -. phiPn =  phi*Pn  =      20294.48 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1615.17
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20294.48

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{353.69}{2712.54} = 0.130 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{572.19}{3285.85} = 0.174 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.040 + [\ 0.130 + 0.174\ ]$$

$$= 0.344 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 413.20 kN.

$$\frac{Vuy}{phiVny} = \frac{413.20}{6856.22} = 0.060 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 252.40 kN.

$$\frac{Vuz}{phiVnz} = \frac{252.40}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102121,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04468e+000,  Lz   = 1.04468e+000,  Lb   = 1.04468e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1614.04	-324.63	-354.29	-1008.38	-583.95
TOTAL	-1614.04	-324.63	-354.29	-1008.38	-583.95

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1614.04 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848633.88 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4687125.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1614.04	-354.29	-583.95
TOTAL	-1614.04	-354.29	-583.95

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -354.29 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -583.95 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848633.8845 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8658e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848633.8845 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.10 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.95 kN.
          -. phiPn =  phi*Pn  =      20424.55 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1614.04
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20424.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{354.29}{2713.75} = 0.131 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{583.95}{3288.12} = 0.178 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.040 + [\ 0.131 + 0.178\ ]$$

$$= 0.348 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 408.03 kN.
Vuy 408.03
-. -------- = --------------- = 0.049 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 233.98 kN.
Vuz 233.98
-. -------- = --------------- = 0.038 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.17083e+000,  Lz   = 2.17083e+000,  Lb   = 2.17083e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2282.44	-781.98	-211.57	-198.95	-231.58
TOTAL	-2282.44	-781.98	-211.57	-198.95	-231.58

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2282.44 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.98
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1848
Pey = (Area*Fy)/Lambda^2 = 685919.90 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.51
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1389
Pez = (Area*Fy)/Lambda^2 = 1213847.67 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2282.44	-781.98	-198.95
TOTAL	-2282.44	-781.98	-198.95

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -781.98 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -198.95 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.0 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  23426.7240 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  =  685919.8993 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      2.171 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.2727e+037 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  =  685919.8993 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =         29.28 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       23094.22 kN.
           -. phiPn =  phi*Pn  =      20784.80 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              2282.44
           -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
               phiPn           20784.80

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.86 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.86 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{781.98}{2819.86} = 0.277 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.35 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.35 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.35 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{198.95}{3511.35} = 0.057 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.055 + [\ 0.277 + 0.057\ ]$$

$$= 0.389 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 191.32 kN.

$$\frac{Vuy}{phiVny} = \frac{191.32}{6856.22} = 0.028 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = I)
-. Applied shear force : Vuz = 279.37 kN.

$$\frac{Vuz}{phiVnz} = \frac{279.37}{6094.42} = 0.046 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.60668e-001,  Lz   = 8.60668e-001,  Lb   = 8.60668e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2301.94	-799.79	-781.59	-354.19	-202.78
TOTAL	-2301.94	-799.79	-781.59	-354.19	-202.78

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2301.94 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0733
Pey = (Area*Fy)/Lambda^2 = 4363685.82 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.17
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0551
Pez = (Area*Fy)/Lambda^2 = 7722257.20 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2301.94	-781.59	-202.78
TOTAL	-2301.94	-781.59	-202.78

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -781.59 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -202.78 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4363685.8175 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.861 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.9905e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4363685.8175 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        186.27 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23374.14 kN.
          -. phiPn =  phi*Pn  =      21036.73 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2301.94
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           21036.73

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2821.98 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2821.98 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                781.59
           -. --------  =  ---------------  =  0.277  <  1.000  --->  O.K.
               phiMny             2821.98

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.72 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.72 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.72 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                202.78
           -. --------  =  ---------------  =  0.058  <  1.000  --->  O.K.
               phiMnz             3515.72

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.055 + [  0.277  +  0.058 ]
                      =  0.389  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 182.89 kN.

$$\frac{Vuy}{phiVny} = \frac{182.89}{8654.07} = 0.021 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 124.94 kN.

$$\frac{Vuz}{phiVnz} = \frac{124.94}{6094.42} = 0.021 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 102140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.23129e+000,  Lz   = 2.23129e+000,  Lb   = 2.23129e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                  Version 8.8.5
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      ( ). Compute moment magnification factors(B1y,B1z).
           -. If tension or bending member.
           -. Assumed   B1y  =  1.00
           -. Assumed   B1z  =  1.00

      ( ). Magnification factors for sidesway moments(B2y,B2z).
           -. B2y   =  1.00 (Default value)
           -. B2z   =  1.00 (Default value)

      ( ). Given factored axial forces and moments at <I>.
           ---------------------------------------------------------------
            Load Case             Pu                My                Mz
           ---------------------------------------------------------------
            DL                  0.00              0.00              0.00
            LL                  0.00              0.00              0.00
            DL+LL               0.00              0.00              0.00
            OTHER CASES      1977.70            740.39            236.55
           ---------------------------------------------------------------
            TOTAL            1977.70            740.39            236.55
           ---------------------------------------------------------------

      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =      740.39 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =      236.55 kN-m.

================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
================================================================================

      ( ). Check slenderness ratio of axial tension member (l/r).
           [ AASHTO-LRFD12 Specification 6.8.4 ]
           -. l/r  =    14.4  <   200.0  --->  O.K.

      ( ). Calculate axial tensile strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.8.2.1-1 ]
           -. Resistance factor for tension  :  phi = 0.95
           -. phiPn  =  phi*Fy*Ag  =      22255.39 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1977.70
           -. -------  =  ---------------  =  0.089  <  1.000  --->  O.K.
               phiPn           22255.39

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.76 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.76 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{740.39}{2819.76} = 0.263 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.15 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.15 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.15 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{236.55}{3511.15} = 0.067 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.044 + [\ 0.263 + 0.067\ ]$$

$$= 0.374 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 197.02 kN.
-. Vuy / phiVny = 197.02 / 6856.22 = 0.029 < 1.000 ---> O.K.

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 289.09 kN.
-. Vuz / phiVnz = 289.09 / 6094.42 = 0.047 < 1.000 ---> O.K.

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.49508e-001,  Lz   = 9.49508e-001,  Lb   = 9.49508e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      ( ). Compute moment magnification factors(B1y,B1z).
           -. If tension or bending member.
           -. Assumed   B1y  =  1.00
           -. Assumed   B1z  =  1.00

      ( ). Magnification factors for sidesway moments(B2y,B2z).
           -. B2y   =  1.00 (Default value)
           -. B2z   =  1.00 (Default value)

      ( ). Given factored axial forces and moments at <J>.
           ---------------------------------------------------------------
            Load Case             Pu                My                Mz
           ---------------------------------------------------------------
            DL                  0.00              0.00              0.00
            LL                  0.00              0.00              0.00
            DL+LL               0.00              0.00              0.00
            OTHER CASES      1994.45            740.95            234.44
           ---------------------------------------------------------------
            TOTAL            1994.45            740.95            234.44
           ---------------------------------------------------------------

      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =      740.95 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =      234.44 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial tension member (l/r).
           [ AASHTO-LRFD12 Specification 6.8.4 ]
           -. l/r  =     6.1  <   200.0  --->  O.K.

      ( ). Calculate axial tensile strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.8.2.1-1 ]
           -. Resistance factor for tension  :  phi = 0.95
           -. phiPn  =  phi*Fy*Ag  =      22255.39 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1994.45
           -. -------  =  ---------------  =  0.090  <  1.000  --->  O.K.
               phiPn           22255.39

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
============================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.83 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.83 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{740.95}{2821.83} = 0.263 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.43 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.43 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.43 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{234.44}{3515.43} = 0.067 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.045 + [\ 0.263 + 0.067\ ]$$

$$= 0.374 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 200.66 kN.

$$\frac{Vuy}{phiVny} = \frac{200.66}{8654.07} = 0.023 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 169.10 kN.

$$\frac{Vuz}{phiVnz} = \frac{169.10}{6094.42} = 0.028 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102210,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78212e+000,  Lz   = 1.78212e+000,  Lb   = 1.78212e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1423.76	-308.29	-288.15	-547.52	-162.82
TOTAL	-1423.76	-308.29	-288.15	-547.52	-162.82

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1423.76 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 978876.72 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610637.91 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1423.76	-308.29	-547.52
TOTAL	-1423.76	-308.29	-547.52

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -308.29 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -547.52 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  978876.7235 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8479e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  978876.7235 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          42.99 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.38 kN.
          -. phiPn =  phi*Pn  =      20294.45 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1423.76
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20294.45

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                308.29
           -. --------  =  ---------------  =  0.114  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                547.52
           -. --------  =  ---------------  =  0.167  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.035 + [  0.114  +  0.167 ]
                      =  0.315  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 406.90 kN.
Vuy 406.90
-. -------- = --------------- = 0.059 < 1.000 ---> O.K.
phiVny 6856.22

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 252.42 kN.
Vuz 252.42
-. -------- = --------------- = 0.041 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================

      *. PROJECT     :
      *. MEMBER NO   = 102211,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04453e+000,  Lz   = 1.04453e+000,  Lb   = 1.04453e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1423.19	-299.99	-308.59	-955.54	-560.44
TOTAL	-1423.19	-299.99	-308.59	-955.54	-560.44

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1423.19 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2849419.77 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4688418.26 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1423.19	-308.59	-560.44
TOTAL	-1423.19	-308.59	-560.44

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      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =     -308.59 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =     -560.44 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AASHTO-LRFD12 Specification 6.9.3 ]
           -. Kl/r  =     6.8  <   120.0  --->  O.K.

      ------------------------------------------------------------------------
      [*]  Calculate Qa about y-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  Cw - tw   =    0.47 m.
           -. DTRf  =  Dflg/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
           -. Dweb  =  H-tf1-tf2 =    0.32 m.
           -. DTRw  =  Dweb/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa1 =  A_eff/Area  =   1.000  (about y-axis).

      ------------------------------------------------------------------------
      [*]  Calculate Qa about z-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  H-tf1-tf2 =    0.32 m.
           -. DTRf  =  Dflg/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
```

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2849419.7700 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8666e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2849419.7700 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.14 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.97 kN.
          -. phiPn =  phi*Pn  =      20424.57 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1423.19
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20424.57

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{308.59}{2713.75} = 0.114 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{560.44}{3288.12} = 0.170 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.035 + [\ 0.114 + 0.170\ ]$$

$$= 0.319 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 401.50 kN.

$$\frac{Vuy}{phiVny} = \frac{401.50}{8273.17} = 0.049 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 228.26 kN.

$$\frac{Vuz}{phiVnz} = \frac{228.26}{6094.42} = 0.037 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================

      *. PROJECT     :
      *. MEMBER NO   = 102220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78212e+000,  Lz   = 1.78212e+000,  Lb   = 1.78212e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1114.97	-377.73	-305.33	-596.43	-109.55
TOTAL	-1114.97	-377.73	-305.33	-596.43	-109.55

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1114.97 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 978876.72 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610637.91 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1114.97	-377.73	-596.43
TOTAL	-1114.97	-377.73	-596.43

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -377.73 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -596.43 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  978876.7235 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8479e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  978876.7235 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          42.99 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.38 kN.
          -. phiPn =  phi*Pn  =      20294.45 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1114.97
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.45

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                377.73
           -. --------  =  ---------------  =  0.139  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                596.43
           -. --------  =  ---------------  =  0.182  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.027 + [  0.139  +  0.182 ]
                      =  0.348  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 381.02 kN.

$$\text{Vuy} / \text{phiVny} = 381.02 / 6856.22 = 0.056 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 289.83 kN.

$$\text{Vuz} / \text{phiVnz} = 289.83 / 6094.42 = 0.048 < 1.000 \text{ ---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 102221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04468e+000,  Lz   = 1.04468e+000,  Lb   = 1.04468e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1133.58	-545.52	-377.38	-1004.16	-612.38
TOTAL	-1133.58	-545.52	-377.38	-1004.16	-612.38

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1133.58 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848633.88 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4687125.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1133.58	-377.38	-612.38
TOTAL	-1133.58	-377.38	-612.38

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -377.38 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -612.38 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 2848633.8845 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.045 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8658e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 2848633.8845 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        125.10 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22693.95 kN.
           -. phiPn =  phi*Pn  =      20424.55 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1133.58
           -. -------  =  ---------------  =          0.06  <  1.000  --->  O.K.
              phiPn           20424.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{377.38}{2713.75} = 0.139 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{612.38}{3288.12} = 0.186 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.028 + [\ 0.139 + 0.186\ ]$$

$$= 0.353 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 375.13 kN.

$$\frac{Vuy}{phiVny} = \frac{375.13}{8273.17} = 0.045 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 301.64 kN.

$$\frac{Vuz}{phiVnz} = \frac{301.64}{6094.42} = 0.049 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.22093e+000,  Lz   = 2.22093e+000,  Lb   = 2.22093e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2276.18	-795.62	-233.10	-130.13	-255.61
TOTAL	-2276.18	-795.62	-233.10	-130.13	-255.61

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2276.18 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.31
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1891
Pey = (Area*Fy)/Lambda^2 = 655322.19 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.75
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1421
Pez = (Area*Fy)/Lambda^2 = 1159700.00 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2276.18	-795.62	-130.13
TOTAL	-2276.18	-795.62	-130.13

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -795.62 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -130.13 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  655322.1850 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.221 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.9929e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  655322.1850 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         27.97 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23078.81 kN.
          -. phiPn =  phi*Pn  =      20770.93 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2276.18
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20770.93

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.78 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.78 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{795.62}{2819.78} = 0.282 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.18 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.18 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.18 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{130.13}{3511.18} = 0.037 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.055 + [\ 0.282 + 0.037\ ]$$

$$= 0.374 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 167.89 kN.

$$\frac{Vuy}{phiVny} = \frac{167.89}{6856.22} = 0.024 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = I)
-. Applied shear force : Vuz = 270.67 kN.

$$\frac{Vuz}{phiVnz} = \frac{270.67}{6094.42} = 0.044 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 102231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.76225e-001,  Lz   = 8.76225e-001,  Lb   = 8.76225e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2293.95	-807.48	-795.69	-247.67	-129.77
TOTAL	-2293.95	-807.48	-795.69	-247.67	-129.77

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2293.95 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.64
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0746
Pey = (Area*Fy)/Lambda^2 = 4210109.88 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.24
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0561
Pez = (Area*Fy)/Lambda^2 = 7450479.41 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2293.95	-795.69	-129.77
TOTAL	-2293.95	-795.69	-129.77

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -795.69 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -129.77 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.6 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4210109.8756 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.876 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.8501e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4210109.8756 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        179.71 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23372.23 kN.
          -. phiPn =  phi*Pn  =      21035.00 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2293.95
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           21035.00

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{795.69}{2821.95} = 0.282 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.67 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.67 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.67 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{129.77}{3515.67} = 0.037 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.055 + [\ 0.282 + 0.037\ ]$$

$$= 0.373 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 172.91 kN.

$$\frac{Vuy}{phiVny} = \frac{172.91}{8654.07} = 0.020 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 124.43 kN.

$$\frac{Vuz}{phiVnz} = \frac{124.43}{6094.42} = 0.020 < 1.000 \text{ ---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 102240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.28107e+000,  Lz   = 2.28107e+000,  Lb   = 2.28107e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2402.94	-740.99	-286.70	-207.43	-244.33
TOTAL	-2402.94	-740.99	-286.70	-207.43	-244.33

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2402.94 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.69
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1942
Pey = (Area*Fy)/Lambda^2 = 621221.92 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.04
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1460
Pez = (Area*Fy)/Lambda^2 = 1099353.99 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2402.94	-740.99	-207.43
TOTAL	-2402.94	-740.99	-207.43

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -740.99 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -207.43 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.7 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  621221.9162 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.281 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.6810e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  621221.9162 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          26.52 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23059.86 kN.
          -. phiPn =  phi*Pn  =      20753.88 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2402.94
          -. -------  =  ---------------  =          0.12  <  1.000  --->  O.K.
              phiPn           20753.88

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.68 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.68 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                740.99
           -. --------  =  ---------------  =  0.263  <  1.000  --->  O.K.
              phiMny             2819.68

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3510.98 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3510.98 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3510.98 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                207.43
           -. --------  =  ---------------  =  0.059  <  1.000  --->  O.K.
              phiMnz             3510.98

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.058 + [  0.263  +  0.059 ]
                      =  0.380  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 168.11 kN.

$$\frac{Vuy}{phiVny} = \frac{168.11}{6856.22} = 0.025 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 297.91 kN.

$$\frac{Vuz}{phiVnz} = \frac{297.91}{6094.42} = 0.049 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 102241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.66450e-001,  Lz   = 9.66450e-001,  Lb   = 9.66450e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2415.13	-769.53	-740.92	-361.44	-210.07
TOTAL	-2415.13	-769.53	-740.92	-361.44	-210.07

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2415.13 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.22
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0823
Pey = (Area*Fy)/Lambda^2 = 3460721.36 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.68
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0618
Pez = (Area*Fy)/Lambda^2 = 6124313.61 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2415.13	-740.92	-210.07
TOTAL	-2415.13	-740.92	-210.07

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -740.92 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -210.07 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.2 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3460721.3611 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.966 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.1648e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3460721.3611 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        147.73 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23360.44 kN.
          -. phiPn =  phi*Pn  =      21024.40 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2415.13
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           21024.40

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.80 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.80 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{740.92}{2821.80} = 0.263 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.37 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.37 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.37 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{210.07}{3515.37} = 0.060 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.057 + [\ 0.263 + 0.060\ ]$$

$$= 0.380 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 161.56 kN.

$$\frac{Vuy}{phiVny} = \frac{161.56}{8654.07} = 0.019 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 171.87 kN.

$$\frac{Vuz}{phiVnz} = \frac{171.87}{6094.42} = 0.028 < 1.000 \quad ---> \quad O.K.$$

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------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================

      *. PROJECT     :
      *. MEMBER NO   = 103110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78196e+000,  Lz   = 1.78196e+000,  Lb   = 1.78196e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-950.72	-351.43	-303.33	-436.51	-127.02
TOTAL	-950.72	-351.43	-303.33	-436.51	-127.02

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 950.72 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979052.44 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610927.03 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-950.72	-351.43	-436.51
TOTAL	-950.72	-351.43	-436.51

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -351.43 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -436.51 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979052.4384 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8497e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979052.4384 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.42 kN.
          -. phiPn =  phi*Pn  =      20294.48 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               950.72
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.48

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{351.43}{2712.54} = 0.130 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{436.51}{3285.85} = 0.133 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.023 + [\ 0.130 + 0.133\ ]$$

$$= 0.286 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 315.80 kN.

$$\frac{Vuy}{phiVny} = \frac{315.80}{6856.22} = 0.046 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 369.58 kN.

$$\frac{Vuz}{phiVnz} = \frac{369.58}{6094.42} = 0.061 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 103111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04462e+000,  Lz   = 1.04462e+000,  Lb   = 1.04462e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-961.09	-538.78	-351.53	-740.23	-447.36
TOTAL	-961.09	-538.78	-351.53	-740.23	-447.36

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 961.09 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848965.42 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4687670.67 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-961.09	-351.53	-447.36
TOTAL	-961.09	-351.53	-447.36

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -351.53 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -447.36 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848965.4179 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8662e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848965.4179 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.12 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.96 kN.
          -. phiPn =  phi*Pn  =      20424.56 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              961.09
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20424.56

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                351.53
           -. --------  =  ---------------  =  0.130  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                447.36
           -. --------  =  ---------------  =  0.136  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.024 + [  0.130  +  0.136 ]
                      =  0.289  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 310.14 kN.

$$\frac{Vuy}{phiVny} = \frac{310.14}{8273.17} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 409.88 kN.

$$\frac{Vuz}{phiVnz} = \frac{409.88}{6094.42} = 0.067 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 103120,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78196e+000,  Lz   = 1.78196e+000,  Lb   = 1.78196e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2175.85	-572.87	-357.03	-286.69	-95.60
TOTAL	-2175.85	-572.87	-357.03	-286.69	-95.60

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2175.85 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979052.44 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610927.03 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2175.85	-572.87	-286.69
TOTAL	-2175.85	-572.87	-286.69

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      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =     -572.87 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =     -286.69 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AASHTO-LRFD12 Specification 6.9.3 ]
           -. Kl/r  =    11.5  <   120.0  --->  O.K.

      ----------------------------------------------------------------------------
      [*]  Calculate Qa about y-axis (Sqaure and rectangular section).
      ----------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  Cw - tw   =    0.47 m.
           -. DTRf  =  Dflg/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
           -. Dweb  =  H-tf1-tf2 =    0.32 m.
           -. DTRw  =  Dweb/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa1 =  A_eff/Area  =   1.000  (about y-axis).

      ----------------------------------------------------------------------------
      [*]  Calculate Qa about z-axis (Sqaure and rectangular section).
      ----------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  H-tf1-tf2 =    0.32 m.
           -. DTRf  =  Dflg/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
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          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979052.4384 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8497e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979052.4384 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.42 kN.
          -. phiPn =  phi*Pn  =      20294.48 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2175.85
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20294.48

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                572.87
           -. --------  =  ---------------  =  0.211  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                286.69
           -. --------  =  ---------------  =  0.087  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.054 + [  0.211  +  0.087 ]
                      =  0.352  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 312.70 kN.

$$\frac{Vuy}{phiVny} = \frac{312.70}{6856.22} = 0.046 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 262.66 kN.

$$\frac{Vuz}{phiVnz} = \frac{262.66}{6094.42} = 0.043 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 103121,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04462e+000,  Lz   = 1.04462e+000,  Lb   = 1.04462e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2179.57	-513.43	-572.90	-487.47	-292.06
TOTAL	-2179.57	-513.43	-572.90	-487.47	-292.06

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2179.57 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848965.42 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4687670.67 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2179.57	-572.90	-292.06
TOTAL	-2179.57	-572.90	-292.06

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -572.90 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -292.06 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848965.4179 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8662e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848965.4179 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.12 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.96 kN.
          -. phiPn =  phi*Pn  =      20424.56 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2179.57
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20424.56

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{572.90}{2713.75} = 0.211 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{292.06}{3288.12} = 0.089 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.053 + [\ 0.211 + 0.089\ ]$$

$$= 0.353 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 306.98 kN.

$$\frac{Vuy}{phiVny} = \frac{306.98}{8273.17} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 229.38 kN.

$$\frac{Vuz}{phiVnz} = \frac{229.38}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 103130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.14470e+000,  Lz   = 2.14470e+000,  Lb   = 2.14470e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1720.80	-590.84	-163.16	-180.21	-199.43
TOTAL	-1720.80	-590.84	-163.16	-180.21	-199.43

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1720.80 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1826
Pey = (Area*Fy)/Lambda^2 = 702733.90 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.38
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1373
Pez = (Area*Fy)/Lambda^2 = 1243602.81 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1720.80	-590.84	-180.21
TOTAL	-1720.80	-590.84	-180.21

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -590.84 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -180.21 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 13.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  702733.9028 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.145 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.4264e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  702733.9028 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          30.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23102.12 kN.
          -. phiPn =  phi*Pn  =      20791.91 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1720.80
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20791.91

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                Version 8.8.5
================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.90 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.90 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               590.84
           -. --------  =  ---------------  =  0.210  <  1.000  --->  O.K.
              phiMny             2819.90

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.43 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.43 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.43 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               180.21
           -. --------  =  ---------------  =  0.051  <  1.000  --->  O.K.
              phiMnz             3511.43

================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.041 + [  0.210  +  0.051 ]
                      =  0.302  <  1.000  --->  O.K.

================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 165.59 kN.

$$\frac{Vuy}{phiVny} = \frac{165.59}{6856.22} = 0.024 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 250.70 kN.

$$\frac{Vuz}{phiVnz} = \frac{250.70}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 103131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.22206e-001,  Lz   = 8.22206e-001,  Lb   = 8.22206e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1735.08	-602.06	-590.84	-295.68	-183.09
TOTAL	-1735.08	-602.06	-590.84	-295.68	-183.09

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1735.08 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.30
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0700
Pey = (Area*Fy)/Lambda^2 = 4781501.59 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 3.98
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0526
Pez = (Area*Fy)/Lambda^2 = 8461650.69 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1735.08	-590.84	-183.09
TOTAL	-1735.08	-590.84	-183.09

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -590.84 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -183.09 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4781501.5921 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.822 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.3726e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4781501.5921 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        204.10 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23378.73 kN.
          -. phiPn =  phi*Pn  =      21040.86 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1735.08
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21040.86

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2822.04 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2822.04 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{590.84}{2822.04} = 0.209 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{183.09}{3515.85} = 0.052 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.041 + [\ 0.209 + 0.052\ ]$$

$$= 0.303 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 161.21 kN.

$$\frac{Vuy}{phiVny} = \frac{161.21}{8654.07} = 0.019 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 197.37 kN.

$$\frac{Vuz}{phiVnz} = \frac{197.37}{6094.42} = 0.032 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 103140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.23121e+000,  Lz   = 2.23121e+000,  Lb   = 2.23121e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1949.79	-623.02	-223.16	-188.79	-201.69
TOTAL	-1949.79	-623.02	-223.16	-188.79	-201.69

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1949.79 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.37
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1899
Pey = (Area*Fy)/Lambda^2 = 649296.70 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.80
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1428
Pez = (Area*Fy)/Lambda^2 = 1149036.93 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1949.79	-623.02	-188.79
TOTAL	-1949.79	-623.02	-188.79

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -623.02 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -188.79 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  649296.7030 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.231 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.9378e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  649296.7030 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         27.72 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23075.61 kN.
          -. phiPn =  phi*Pn  =      20768.05 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1949.79
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20768.05

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.76 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.76 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{623.02}{2819.76} = 0.221 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.15 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.15 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.15 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{188.79}{3511.15} = 0.054 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.047 + [\ 0.221 + 0.054\ ]$$

$$= 0.322 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 149.00 kN.

$$\frac{Vuy}{phiVny} = \frac{149.00}{6856.22} = 0.022 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 243.19 kN.

$$\frac{Vuz}{phiVnz} = \frac{243.19}{6094.42} = 0.040 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 103141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.49876e-001,  Lz   = 9.49876e-001,  Lb   = 9.49876e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1962.62	-668.84	-622.89	-288.29	-192.55
TOTAL	-1962.62	-668.84	-622.89	-288.29	-192.55

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1962.62 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.12
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0809
Pey = (Area*Fy)/Lambda^2 = 3582539.80 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.60
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0608
Pez = (Area*Fy)/Lambda^2 = 6339891.30 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1962.62	-622.89	-192.55
TOTAL	-1962.62	-622.89	-192.55

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -622.89 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -192.55 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  23426.7240 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 3582539.7963 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      0.950 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.2762e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 3582539.7963 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        152.93 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       23362.69 kN.
           -. phiPn =  phi*Pn  =      21026.42 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1962.62
           -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn            21026.42

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.83 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.83 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{622.89}{2821.83} = 0.221 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.43 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.43 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.43 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{192.55}{3515.43} = 0.055 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.047 + [\ 0.221 + 0.055\ ]$$

$$= 0.322 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 140.42 kN.

$$\frac{Vuy}{phiVny} = \frac{140.42}{8654.07} = 0.016 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 147.42 kN.

$$\frac{Vuz}{phiVnz} = \frac{147.42}{6094.42} = 0.024 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 103210,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78196e+000,  Lz   = 1.78196e+000,  Lb   = 1.78196e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2181.36	-590.23	-366.36	-281.13	-86.43
TOTAL	-2181.36	-590.23	-366.36	-281.13	-86.43

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2181.36 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979052.44 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610927.03 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2181.36	-590.23	-281.13
TOTAL	-2181.36	-590.23	-281.13

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -590.23 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -281.13 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  979052.4384 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8497e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979052.4384 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.42 kN.
          -. phiPn =  phi*Pn  =      20294.48 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2181.36
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20294.48

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{590.23}{2712.54} = 0.218 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{281.13}{3285.85} = 0.086 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.054 + [\ 0.218 + 0.086\ ]$$

$$= 0.357 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 303.82 kN.

$$\frac{Vuy}{phiVny} = \frac{303.82}{6856.22} = 0.044 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 273.18 kN.

$$\frac{Vuz}{phiVnz} = \frac{273.18}{6094.42} = 0.045 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 103211,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04462e+000,  Lz   = 1.04462e+000,  Lb   = 1.04462e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2185.91	-540.30	-590.18	-494.92	-287.18
TOTAL	-2185.91	-540.30	-590.18	-494.92	-287.18

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2185.91 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848965.42 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4687670.67 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2185.91	-590.18	-287.18
TOTAL	-2185.91	-590.18	-287.18

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -590.18 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -287.18 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848965.4179 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8662e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848965.4179 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.12 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.96 kN.
          -. phiPn =  phi*Pn  =      20424.56 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2185.91
          -. -------  =  ---------------  =          0.11  <  1.000  --->  O.K.
              phiPn           20424.56

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                590.18
           -. --------  =  ---------------  =  0.217  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                287.18
           -. --------  =  ---------------  =  0.087  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.054 + [  0.217  +  0.087 ]
                      =  0.358  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 298.26 kN.

$$\frac{Vuy}{phiVny} = \frac{298.26}{8273.17} = 0.036 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 233.82 kN.

$$\frac{Vuz}{phiVnz} = \frac{233.82}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 103220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78196e+000,  Lz   = 1.78196e+000,  Lb   = 1.78196e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-993.65	-378.14	-322.11	-441.40	-86.11
TOTAL	-993.65	-378.14	-322.11	-441.40	-86.11

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 993.65 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979052.44 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610927.03 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-993.65	-378.14	-441.40
TOTAL	-993.65	-378.14	-441.40

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -378.14 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -441.40 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  979052.4384 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8497e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979052.4384 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.42 kN.
          -. phiPn =  phi*Pn  =      20294.48 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               993.65
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.48

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{378.14}{2712.54} = 0.139 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{441.40}{3285.85} = 0.134 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.024 + [\ 0.139 + 0.134\ ]$$

$$= 0.298 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 327.61 kN.

$$\frac{Vuy}{phiVny} = \frac{327.61}{6856.22} = 0.048 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 387.43 kN.

$$\frac{Vuz}{phiVnz} = \frac{387.43}{6094.42} = 0.064 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 103221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04462e+000,  Lz   = 1.04462e+000,  Lb   = 1.04462e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1008.89	-579.13	-378.00	-786.90	-451.40
TOTAL	-1008.89	-579.13	-378.00	-786.90	-451.40

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1008.89 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848965.42 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4687670.67 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1008.89	-378.00	-451.40
TOTAL	-1008.89	-378.00	-451.40

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -378.00 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -451.40 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 2848965.4179 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8662e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848965.4179 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.12 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.96 kN.
          -. phiPn =  phi*Pn  =      20424.56 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1008.89
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20424.56

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{378.00}{2713.75} = 0.139 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{451.40}{3288.12} = 0.137 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.025 + [\ 0.139 + 0.137\ ]$$

$$= 0.301 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 322.08 kN.

$$\frac{Vuy}{phiVny} = \frac{322.08}{8273.17} = 0.039 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 428.19 kN.

$$\frac{Vuz}{phiVnz} = \frac{428.19}{6094.42} = 0.070 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 103230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.19582e+000,  Lz   = 2.19582e+000,  Lb   = 2.19582e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1749.72	-635.88	-156.21	-117.76	-197.23
TOTAL	-1749.72	-635.88	-156.21	-117.76	-197.23

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1749.72 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.14
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1869
Pey = (Area*Fy)/Lambda^2 = 670395.20 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.63
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1405
Pez = (Area*Fy)/Lambda^2 = 1186374.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1749.72	-635.88	-117.76
TOTAL	-1749.72	-635.88	-117.76

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -635.88 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -117.76 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  670395.1958 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.196 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.1307e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  670395.1958 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          28.62 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23086.58 kN.
          -. phiPn =  phi*Pn  =      20777.92 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1749.72
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20777.92

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.82 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.82 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{635.88}{2819.82} = 0.226 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.26 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.26 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.26 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{117.76}{3511.26} = 0.034 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.042 + [\ 0.226 + 0.034\ ]$$

$$= 0.301 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 160.16 kN.
Vuy 160.16
-. -------- = --------------- = 0.023 < 1.000 ---> O.K.
phiVny 6856.22

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 275.11 kN.
Vuz 275.11
-. -------- = --------------- = 0.045 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 103231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.37016e-001,  Lz   = 8.37016e-001,  Lb   = 8.37016e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1767.10	-658.52	-635.86	-193.94	-121.25
TOTAL	-1767.10	-658.52	-635.86	-193.94	-121.25

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1767.10 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.39
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0713
Pey = (Area*Fy)/Lambda^2 = 4613792.95 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.05
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0536
Pez = (Area*Fy)/Lambda^2 = 8164862.76 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1767.10	-635.86	-121.25
TOTAL	-1767.10	-635.86	-121.25

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -635.86 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -121.25 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4613792.9464 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.837 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.2193e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4613792.9464 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        196.95 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23376.99 kN.
          -. phiPn =  phi*Pn  =      21039.29 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1767.10
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21039.29

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2822.01 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2822.01 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{635.86}{2822.01} = 0.225 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.80 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.80 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.80 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{121.25}{3515.80} = 0.034 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.042 + [\ 0.225 + 0.034\ ]$$

$$= 0.302 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 157.21 kN.

$$\frac{Vuy}{phiVny} = \frac{157.21}{8654.07} = 0.018 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 206.30 kN.

$$\frac{Vuz}{phiVnz} = \frac{206.30}{6094.42} = 0.034 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 103240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.28057e+000,  Lz   = 2.28057e+000,  Lb   = 2.28057e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1946.50	-632.28	-226.60	-187.41	-178.51
TOTAL	-1946.50	-632.28	-226.60	-187.41	-178.51

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1946.50 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.69
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1941
Pey = (Area*Fy)/Lambda^2 = 621494.72 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.04
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1459
Pez = (Area*Fy)/Lambda^2 = 1099836.77 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1946.50	-632.28	-187.41
TOTAL	-1946.50	-632.28	-187.41

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -632.28 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -187.41 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.7 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  621494.7230 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.281 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.6835e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  621494.7230 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          26.53 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23060.02 kN.
          -. phiPn =  phi*Pn  =      20754.02 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1946.50
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20754.02

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.68 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.68 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               632.28
           -. --------  =  ---------------  =  0.224  <  1.000  --->  O.K.
              phiMny             2819.68

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3510.98 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3510.98 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3510.98 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               187.41
           -. --------  =  ---------------  =  0.053  <  1.000  --->  O.K.
              phiMnz             3510.98

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.047 + [  0.224  +  0.053 ]
                      =  0.325  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 143.81 kN.

$$\frac{Vuy}{phiVny} = \frac{143.81}{6856.22} = 0.021 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 245.34 kN.

$$\frac{Vuz}{phiVnz} = \frac{245.34}{6094.42} = 0.040 < 1.000 \quad ---> \quad O.K.$$

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============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 103241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.66682e-001,  Lz   = 9.66682e-001,  Lb   = 9.66682e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1958.91	-680.17	-632.37	-294.57	-190.29
TOTAL	-1958.91	-680.17	-632.37	-294.57	-190.29

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1958.91 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.23
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0823
Pey = (Area*Fy)/Lambda^2 = 3459058.54 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.68
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0619
Pez = (Area*Fy)/Lambda^2 = 6121370.98 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1958.91	-632.37	-190.29
TOTAL	-1958.91	-632.37	-190.29

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -632.37 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -190.29 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.2 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3459058.5391 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.967 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.1633e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3459058.5391 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        147.65 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23360.41 kN.
          -. phiPn =  phi*Pn  =      21024.37 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1958.91
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           21024.37

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.80 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.80 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{632.37}{2821.80} = 0.224 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.37 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.37 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.37 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{190.29}{3515.37} = 0.054 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.047 + [\ 0.224 + 0.054\ ]$$

$$= 0.325 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 143.66 kN.

$$\frac{Vuy}{phiVny} = \frac{143.66}{8654.07} = 0.017 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 153.75 kN.

$$\frac{Vuz}{phiVnz} = \frac{153.75}{6094.42} = 0.025 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 104101,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    13
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-1.5_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.863,  Flg Width   =      0.863,  Web Center  =      0.825
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.25715e-001,  Asy  = 6.57606e-002,  Asz  = 6.57606e-002
         Ybar = 4.31500e-001,  Zbar = 4.31500e-001,  Qyb  = 2.55354e-001,  Qzb  = 2.55354e-001
         Syy  = 3.31118e-002,  Szz  = 3.31118e-002,  Zyy  = 3.89159e-002,  Zzz  = 3.89159e-002
         Iyy  = 1.42877e-002,  Izz  = 1.42877e-002,  Iyz  = 0.00000e+000
         ry   = 3.37123e-001,  rz   = 3.37123e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.45000e+000,  Lz   = 1.45000e+000,  Lb   = 1.45000e+000
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2329.54	-1784.33	-3018.61	-934.99	-1637.44
TOTAL	-2329.54	-1784.33	-3018.61	-934.99	-1637.44

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2329.54 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 9.96
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1317
Pey = (Area*Fy)/Lambda^2 = 2156521.11 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.96
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1317
Pez = (Area*Fy)/Lambda^2 = 2156521.11 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2329.54	-3018.61	-1637.44
TOTAL	-2329.54	-3018.61	-1637.44

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -3018.61 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -1637.44 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 10.0 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2156521.1106 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.450 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.5402e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2156521.1106 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          57.66 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       37131.33 kN.
          -. phiPn =  phi*Pn  =      33418.19 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2329.54
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           33418.19

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 8442.98 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 8442.98 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{3018.61}{8442.98} = 0.358 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8442.98 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8442.98 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8442.98 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{1637.44}{8442.98} = 0.194 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.035 + [\ 0.358 + 0.194\ ]$$

$$= 0.586 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 780.20 kN.

$$\frac{Vuy}{phiVny} = \frac{780.20}{11427.03} = 0.068 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 851.72 kN.

$$\frac{Vuz}{phiVnz} = \frac{851.72}{11427.03} = 0.075 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78183e+000,  Lz   = 1.78183e+000,  Lb   = 1.78183e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-804.07	-604.92	-487.58	-300.25	-57.03
TOTAL	-804.07	-604.92	-487.58	-300.25	-57.03

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 804.07 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979189.66 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611152.82 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-804.07	-604.92	-300.25
TOTAL	-804.07	-604.92	-300.25

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -604.92 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -300.25 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  =  979189.6631 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.782 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8511e+037 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  =  979189.6631 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =           0.90
           -. Pe/Po =          43.00 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22549.45 kN.
           -. phiPn =  phi*Pn  =      20294.51 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu               804.07
           -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20294.51

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{604.92}{2712.54} = 0.223 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{300.25}{3285.85} = 0.091 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.020 + [\ 0.223 + 0.091\ ]$$

$$= 0.334 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 325.90 kN.

$$\frac{Vuy}{phiVny} = \frac{325.90}{6856.22} = 0.048 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 523.20 kN.

$$\frac{Vuz}{phiVnz} = \frac{523.20}{6094.42} = 0.086 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04477e+000,  Lz   = 1.04477e+000,  Lb   = 1.04477e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-827.20	-1066.53	-604.81	-540.24	-306.20
TOTAL	-827.20	-1066.53	-604.81	-540.24	-306.20

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 827.20 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848109.33 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686262.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-827.20	-604.81	-306.20
TOTAL	-827.20	-604.81	-306.20

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -604.81 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -306.20 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848109.3319 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8653e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848109.3319 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.08 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              827.20
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                604.81
           -. --------  =  ---------------  =  0.223  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                306.20
           -. --------  =  ---------------  =  0.093  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.020 + [  0.223  +  0.093 ]
                      =  0.336  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 320.52 kN.

$$\frac{Vuy}{phiVny} = \frac{320.52}{8273.17} = 0.039 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 557.76 kN.

$$\frac{Vuz}{phiVnz} = \frac{557.76}{6094.42} = 0.092 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 104120,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78183e+000,  Lz   = 1.78183e+000,  Lb   = 1.78183e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2855.09	-798.88	-430.39	-276.86	-108.07
TOTAL	-2855.09	-798.88	-430.39	-276.86	-108.07

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2855.09 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979189.66 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611152.82 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2855.09	-798.88	-276.86
TOTAL	-2855.09	-798.88	-276.86

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -798.88 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -276.86 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979189.6631 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8511e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979189.6631 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.45 kN.
          -. phiPn =  phi*Pn  =      20294.51 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2855.09
          -. -------  =  ---------------  =          0.14  <  1.000  --->  O.K.
              phiPn           20294.51

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{798.88}{2712.54} = 0.295 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{276.86}{3285.85} = 0.084 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.070 + [\ 0.295 + 0.084\ ]$$

$$= 0.449 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 341.97 kN.

$$\frac{Vuy}{phiVny} = \frac{341.97}{6856.22} = 0.050 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 337.65 kN.

$$\frac{Vuz}{phiVnz} = \frac{337.65}{6094.42} = 0.055 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104121,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04477e+000,  Lz   = 1.04477e+000,  Lb   = 1.04477e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2864.72	-743.01	-798.81	-503.74	-282.41
TOTAL	-2864.72	-743.01	-798.81	-503.74	-282.41

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2864.72 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848109.33 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686262.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2864.72	-798.81	-282.41
TOTAL	-2864.72	-798.81	-282.41

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -798.81 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -282.41 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848109.3319 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8653e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848109.3319 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.08 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2864.72
          -. -------  =  ---------------  =          0.14  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{798.81}{2713.75} = 0.294 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{282.41}{3288.12} = 0.086 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.070 + [\ 0.294 + 0.086\ ]$$

$$= 0.450 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 335.89 kN.

$$\frac{Vuy}{phiVny} = \frac{335.89}{8273.17} = 0.041 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 226.32 kN.

$$\frac{Vuz}{phiVnz} = \frac{226.32}{6094.42} = 0.037 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.14383e+000,  Lz   = 2.14383e+000,  Lb   = 2.14383e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1744.00	-609.79	-129.87	-321.45	-142.51
TOTAL	-1744.00	-609.79	-129.87	-321.45	-142.51

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1744.00 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1825
Pey = (Area*Fy)/Lambda^2 = 703307.74 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.38
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1372
Pez = (Area*Fy)/Lambda^2 = 1244618.31 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1744.00	-609.79	-321.45
TOTAL	-1744.00	-609.79	-321.45

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -609.79 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -321.45 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 13.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  703307.7413 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.144 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.4317e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  703307.7413 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          30.02 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23102.38 kN.
          -. phiPn =  phi*Pn  =      20792.14 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1744.00
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20792.14

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.90 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.90 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                609.79
           -. --------  =  ---------------  =  0.216  <  1.000  --->  O.K.
              phiMny             2819.90

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.44 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.44 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.44 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                321.45
           -. --------  =  ---------------  =  0.092  <  1.000  --->  O.K.
              phiMnz             3511.44

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.042 + [  0.216  +  0.092 ]
                      =  0.350  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 254.66 kN.

$$\frac{Vuy}{phiVny} = \frac{254.66}{6856.22} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 298.72 kN.

$$\frac{Vuz}{phiVnz} = \frac{298.72}{6094.42} = 0.049 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 104131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.24042e-001,  Lz   = 8.24042e-001,  Lb   = 8.24042e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1763.03	-656.24	-609.63	-473.59	-330.50
TOTAL	-1763.03	-656.24	-609.63	-473.59	-330.50

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1763.03 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.31
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0702
Pey = (Area*Fy)/Lambda^2 = 4760215.11 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 3.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0527
Pez = (Area*Fy)/Lambda^2 = 8423980.77 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1763.03	-609.63	-330.50
TOTAL	-1763.03	-609.63	-330.50

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -609.63 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -330.50 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  23426.7240 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 4760215.1099 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      0.824 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.3532e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 4760215.1099 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        203.20 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       23378.52 kN.
           -. phiPn =  phi*Pn  =      21040.67 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1763.03
           -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
               phiPn           21040.67

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2822.03 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2822.03 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               609.63
           -. --------  =  ---------------  =  0.216  <  1.000  --->  O.K.
              phiMny            2822.03

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               330.50
           -. --------  =  ---------------  =  0.094  <  1.000  --->  O.K.
              phiMnz            3515.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz   ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.042 + [  0.216  +  0.094 ]
                      =  0.352  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 246.56 kN.

$$\frac{Vuy}{phiVny} = \frac{246.56}{8654.07} = 0.028 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 176.29 kN.

$$\frac{Vuz}{phiVnz} = \frac{176.29}{6094.42} = 0.029 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 104140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.25869e+000,  Lz   = 2.25869e+000,  Lb   = 2.25869e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1786.98	-631.66	-154.35	-248.15	-221.70
TOTAL	-1786.98	-631.66	-154.35	-248.15	-221.70

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1786.98 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.55
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1923
Pey = (Area*Fy)/Lambda^2 = 633596.01 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.94
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1445
Pez = (Area*Fy)/Lambda^2 = 1121251.97 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1786.98	-631.66	-248.15
TOTAL	-1786.98	-631.66	-248.15

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -631.66 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -248.15 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  633596.0058 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.259 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.7942e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  633596.0058 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          27.05 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23066.97 kN.
          -. phiPn =  phi*Pn  =      20760.28 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1786.98
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20760.28

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.72 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.72 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                631.66
           -. --------  =  ---------------  =  0.224  <  1.000  --->  O.K.
               phiMny             2819.72

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.05 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.05 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.05 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                248.15
           -. --------  =  ---------------  =  0.071  <  1.000  --->  O.K.
               phiMnz             3511.05

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.043 + [  0.224  +  0.071 ]
                      =  0.338  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 252.82 kN.

$$\frac{Vuy}{phiVny} = \frac{252.82}{6856.22} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 249.79 kN.

$$\frac{Vuz}{phiVnz} = \frac{249.79}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 104141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.88025e-001,  Lz   = 9.88025e-001,  Lb   = 9.88025e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1800.86	-728.92	-631.72	-403.96	-249.62
TOTAL	-1800.86	-728.92	-631.72	-403.96	-249.62

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1800.86 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.36
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0841
Pey = (Area*Fy)/Lambda^2 = 3311230.74 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.78
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0632
Pez = (Area*Fy)/Lambda^2 = 5859765.46 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1800.86	-631.72	-249.62
TOTAL	-1800.86	-631.72	-249.62

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -631.72 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -249.62 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3311230.7395 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.988 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.0281e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3311230.7395 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        141.34 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23357.46 kN.
          -. phiPn =  phi*Pn  =      21021.71 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1800.86
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           21021.71

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.77 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.77 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{631.72}{2821.77} = 0.224 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.30 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.30 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.30 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{249.62}{3515.30} = 0.071 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.043 + [\ 0.224 + 0.071\ ]$$

$$= 0.338 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 246.20 kN.

$$\frac{Vuy}{phiVny} = \frac{246.20}{8654.07} = 0.028 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 182.67 kN.

$$\frac{Vuz}{phiVnz} = \frac{182.67}{6094.42} = 0.030 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 104201,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    13
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-1.5_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.863,  Flg Width   =      0.863,  Web Center  =      0.825
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.25715e-001,  Asy  = 6.57606e-002,  Asz  = 6.57606e-002
         Ybar = 4.31500e-001,  Zbar = 4.31500e-001,  Qyb  = 2.55354e-001,  Qzb  = 2.55354e-001
         Syy  = 3.31118e-002,  Szz  = 3.31118e-002,  Zyy  = 3.89159e-002,  Zzz  = 3.89159e-002
         Iyy  = 1.42877e-002,  Izz  = 1.42877e-002,  Iyz  = 0.00000e+000
         ry   = 3.37123e-001,  rz   = 3.37123e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.45000e+000,  Lz   = 1.45000e+000,  Lb   = 1.45000e+000
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2386.45	-1807.77	-3067.81	-1114.56	-1869.69
TOTAL	-2386.45	-1807.77	-3067.81	-1114.56	-1869.69

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2386.45 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 9.96
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1317
Pey = (Area*Fy)/Lambda^2 = 2156521.11 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.96
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1317
Pez = (Area*Fy)/Lambda^2 = 2156521.11 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2386.45	-3067.81	-1869.69
TOTAL	-2386.45	-3067.81	-1869.69

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -3067.81 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -1869.69 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 10.0 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2156521.1106 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.450 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.5402e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2156521.1106 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          57.66 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       37131.33 kN.
          -. phiPn =  phi*Pn  =      33418.19 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2386.45
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           33418.19

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 8442.98 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 8442.98 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{3067.81}{8442.98} = 0.363 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8442.98 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8442.98 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8442.98 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{1869.69}{8442.98} = 0.221 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.036 + [\ 0.363 + 0.221\ ]$$

$$= 0.621 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 753.54 kN.

$$\text{Vuy} / \text{phiVny} = 753.54 / 11427.03 = 0.066 < 1.000 \quad \text{---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 869.72 kN.

$$\text{Vuz} / \text{phiVnz} = 869.72 / 11427.03 = 0.076 < 1.000 \quad \text{---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 104210,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78254e+000,  Lz   = 1.78254e+000,  Lb   = 1.78254e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2757.49	-777.50	-448.39	-334.48	-123.38
TOTAL	-2757.49	-777.50	-448.39	-334.48	-123.38

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2757.49 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1526
Pey = (Area*Fy)/Lambda^2 = 978414.00 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1609876.55 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2757.49	-777.50	-334.48
TOTAL	-2757.49	-777.50	-334.48

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -777.50 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -334.48 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  978414.0013 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.783 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8433e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  978414.0013 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          42.97 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.28 kN.
          -. phiPn =  phi*Pn  =      20294.35 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2757.49
          -. -------  =  ---------------  =          0.14  <  1.000  --->  O.K.
              phiPn           20294.35

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               777.50
           -. --------  =  ---------------  =  0.287  <  1.000  --->  O.K.
               phiMny            2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               334.48
           -. --------  =  ---------------  =  0.102  <  1.000  --->  O.K.
               phiMnz            3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.068 + [  0.287  +  0.102 ]
                      =  0.456  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 355.96 kN.

$$\frac{Vuy}{phiVny} = \frac{355.96}{6856.22} = 0.052 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 316.30 kN.

$$\frac{Vuz}{phiVnz} = \frac{316.30}{6094.42} = 0.052 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104211,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04477e+000,  Lz   = 1.04477e+000,  Lb   = 1.04477e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2765.35	-709.87	-777.50	-585.81	-341.38
TOTAL	-2765.35	-709.87	-777.50	-585.81	-341.38

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2765.35 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848109.33 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686262.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2765.35	-777.50	-341.38
TOTAL	-2765.35	-777.50	-341.38

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -777.50 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -341.38 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848109.3319 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8653e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848109.3319 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.08 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2765.35
          -. -------  =  ---------------  =          0.14  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{777.50}{2713.75} = 0.287 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{341.38}{3288.12} = 0.104 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.068 + [\ 0.287 + 0.104\ ]$$

$$= 0.458 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 350.59 kN.

$$\frac{Vuy}{phiVny} = \frac{350.59}{8273.17} = 0.042 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 226.95 kN.

$$\frac{Vuz}{phiVnz} = \frac{226.95}{6094.42} = 0.037 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78183e+000,  Lz   = 1.78183e+000,  Lb   = 1.78183e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-940.62	-460.59	-378.92	-468.87	-150.01
TOTAL	-940.62	-460.59	-378.92	-468.87	-150.01

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 940.62 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979189.66 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611152.82 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-940.62	-460.59	-468.87
TOTAL	-940.62	-460.59	-468.87

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -460.59 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -468.87 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979189.6631 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8511e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979189.6631 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.45 kN.
          -. phiPn =  phi*Pn  =      20294.51 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               940.62
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20294.51

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{460.59}{2712.54} = 0.170 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{468.87}{3285.85} = 0.143 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.023 + [\ 0.170 + 0.143\ ]$$

$$= 0.336 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 356.97 kN.
Vuy 356.97
-. -------- = --------------- = 0.052 < 1.000 ---> O.K.
phiVny 6856.22

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 502.31 kN.
Vuz 502.31
-. -------- = --------------- = 0.082 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04477e+000,  Lz   = 1.04477e+000,  Lb   = 1.04477e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-951.86	-761.58	-460.77	-802.47	-479.60
TOTAL	-951.86	-761.58	-460.77	-802.47	-479.60

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 951.86 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848109.33 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686262.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-951.86	-460.77	-479.60
TOTAL	-951.86	-460.77	-479.60

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -460.77 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -479.60 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848109.3319 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8653e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848109.3319 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.08 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              951.86
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{460.77}{2713.75} = 0.170 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{479.60}{3288.12} = 0.146 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.023 + [\ 0.170 + 0.146\ ]$$

$$= 0.339 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 351.05 kN.

$$\frac{Vuy}{phiVny} = \frac{351.05}{8273.17} = 0.042 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 547.99 kN.

$$\frac{Vuz}{phiVnz} = \frac{547.99}{6094.42} = 0.090 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================

      *. PROJECT     :
      *. MEMBER NO   = 104230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.19538e+000,  Lz   = 2.19538e+000,  Lb   = 2.19538e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1716.75	-620.07	-152.25	-313.75	-186.64
TOTAL	-1716.75	-620.07	-152.25	-313.75	-186.64

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1716.75 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.14
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1869
Pey = (Area*Fy)/Lambda^2 = 670663.37 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.63
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1405
Pez = (Area*Fy)/Lambda^2 = 1186848.75 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1716.75	-620.07	-313.75
TOTAL	-1716.75	-620.07	-313.75

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -620.07 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -313.75 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  670663.3702 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.195 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.1331e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  670663.3702 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         28.63 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23086.71 kN.
          -. phiPn =  phi*Pn  =      20778.04 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1716.75
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20778.04

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.82 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.82 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               620.07
           -. --------  =  ---------------  =  0.220  <  1.000  --->  O.K.
              phiMny             2819.82

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.27 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.27 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.27 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               313.75
           -. --------  =  ---------------  =  0.089  <  1.000  --->  O.K.
              phiMnz             3511.27

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.041 + [  0.220  +  0.089 ]
                      =  0.351  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 227.58 kN.

$$\frac{Vuy}{phiVny} = \frac{227.58}{6856.22} = 0.033 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 288.56 kN.

$$\frac{Vuz}{phiVnz} = \frac{288.56}{6094.42} = 0.047 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.38698e-001,  Lz   = 8.38698e-001,  Lb   = 8.38698e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1734.39	-660.00	-619.92	-464.30	-321.67
TOTAL	-1734.39	-660.00	-619.92	-464.30	-321.67

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1734.39 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.40
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0714
Pey = (Area*Fy)/Lambda^2 = 4595302.72 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.06
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0537
Pez = (Area*Fy)/Lambda^2 = 8132141.28 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1734.39	-619.92	-321.67
TOTAL	-1734.39	-619.92	-321.67

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -619.92 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -321.67 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4595302.7226 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.839 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.2024e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4595302.7226 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        196.16 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23376.79 kN.
          -. phiPn =  phi*Pn  =      21039.11 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1734.39
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21039.11

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2822.01 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2822.01 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                619.92
           -. --------  =  ---------------  =  0.220  <  1.000  --->  O.K.
               phiMny             2822.01

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.80 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.80 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.80 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                321.67
           -. --------  =  ---------------  =  0.091  <  1.000  --->  O.K.
               phiMnz             3515.80

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.041 + [  0.220  +  0.091 ]
                      =  0.352  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 225.82 kN.

$$\frac{Vuy}{phiVny} = \frac{225.82}{8654.07} = 0.026 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 174.30 kN.

$$\frac{Vuz}{phiVnz} = \frac{174.30}{6094.42} = 0.029 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 104240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.30707e+000,  Lz   = 2.30707e+000,  Lb   = 2.30707e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1829.91	-614.05	-166.32	-292.03	-202.52
TOTAL	-1829.91	-614.05	-166.32	-292.03	-202.52

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1829.91 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.86
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1964
Pey = (Area*Fy)/Lambda^2 = 607299.75 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.17
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1476
Pez = (Area*Fy)/Lambda^2 = 1074716.43 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1829.91	-614.05	-292.03
TOTAL	-1829.91	-614.05	-292.03

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -614.05 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -292.03 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.9 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  607299.7463 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.307 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.5537e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  607299.7463 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         25.92 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23051.52 kN.
          -. phiPn =  phi*Pn  =      20746.37 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1829.91
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           20746.37

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.64 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.64 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{614.05}{2819.64} = 0.218 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3510.89 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3510.89 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3510.89 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{292.03}{3510.89} = 0.083 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.044 + [\ 0.218 + 0.083\ ]$$

$$= 0.345 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 225.74 kN.

$$\frac{Vuy}{phiVny} = \frac{225.74}{6856.22} = 0.033 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 238.69 kN.

$$\frac{Vuz}{phiVnz} = \frac{238.69}{6094.42} = 0.039 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 104241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.00585e+000,  Lz   = 1.00585e+000,  Lb   = 1.00585e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1843.25	-692.20	-614.05	-485.41	-294.83
TOTAL	-1843.25	-692.20	-614.05	-485.41	-294.83

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1843.25 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.48
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0856
Pey = (Area*Fy)/Lambda^2 = 3194901.71 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.87
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0644
Pez = (Area*Fy)/Lambda^2 = 5653902.17 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1843.25	-614.05	-294.83
TOTAL	-1843.25	-614.05	-294.83

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -614.05 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -294.83 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3194901.7080 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.006 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.9217e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3194901.7080 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        136.38 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23354.94 kN.
          -. phiPn =  phi*Pn  =      21019.44 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1843.25
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           21019.44

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.74 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.74 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{614.05}{2821.74} = 0.218 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.24 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.24 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.24 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{294.83}{3515.24} = 0.084 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.044 + [\ 0.218 + 0.084\ ]$$

$$= 0.345 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 221.90 kN.

$$\frac{Vuy}{phiVny} = \frac{221.90}{8654.07} = 0.026 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 165.94 kN.

$$\frac{Vuz}{phiVnz} = \frac{165.94}{6094.42} = 0.027 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105101,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151+,  MATERIAL NO  =     3,  SECTION NO =    16
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-3.0_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.975,  Flg Width   =      0.975,  Web Center  =      0.937
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.42784e-001,  Asy  = 7.42950e-002,  Asz  = 7.42950e-002
         Ybar = 4.87500e-001,  Zbar = 4.87500e-001,  Qyb  = 3.29350e-001,  Qzb  = 3.29350e-001
         Syy  = 4.29197e-002,  Szz  = 4.29197e-002,  Zyy  = 5.01929e-002,  Zzz  = 5.01929e-002
         Iyy  = 2.09233e-002,  Izz  = 2.09233e-002,  Iyz  = 0.00000e+000
         ry   = 3.82804e-001,  rz   = 3.82804e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 3.30000e+000,  Lz   = 3.30000e+000,  Lb   = 3.30000e+000
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


================================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================================
```

( ). Compute moment magnification factors(B1y,B1z).
-. If tension or bending member.
-. Assumed B1y = 1.00
-. Assumed B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	338.21	2790.80	1594.72
TOTAL	338.21	2790.80	1594.72

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = 2790.80 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = 1594.72 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial tension member (l/r).
[AASHTO-LRFD12 Specification 6.8.4]
-. l/r = 11.3 < 200.0 ---> O.K.

( ). Calculate axial tensile strength (phiPn).
[AASHTO-LRFD12 Specification 6.8.2.1-1]
-. Resistance factor for tension : phi = 0.95
-. phiPn = phi*Fy*Ag = 35531.76 kN.

( ). Check ratio of axial strength (Pu/phiPn).

$$\text{-. } \frac{Pu}{phiPn} = \frac{338.21}{35531.76} = 0.010 < 1.000 \text{ ---> O.K.}$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 8435.66 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 8435.66 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{2790.80}{8435.66} = 0.331 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8435.66 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8435.66 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8435.66 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{1594.72}{8435.66} = 0.189 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.005 + [\ 0.331 + 0.189\ ]$$

$$= 0.525 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 1070.10 kN.

$$\frac{Vuy}{phiVny} = \frac{1070.10}{11427.03} = 0.094 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 584.50 kN.

$$\frac{Vuz}{phiVnz} = \frac{584.50}{11427.03} = 0.051 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78240e+000,  Lz   = 1.78240e+000,  Lb   = 1.78240e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-762.92	-631.73	-538.39	-260.16	-109.60
TOTAL	-762.92	-631.73	-538.39	-260.16	-109.60

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 762.92 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 978561.21 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610118.77 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-762.92	-631.73	-260.16
TOTAL	-762.92	-631.73	-260.16

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -631.73 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -260.16 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  978561.2117 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8447e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  978561.2117 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          42.98 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.31 kN.
          -. phiPn =  phi*Pn  =      20294.38 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               762.92
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20294.38

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{631.73}{2712.54} = 0.233 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{260.16}{3285.85} = 0.079 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.019 + [\ 0.233 + 0.079\ ]$$

$$= 0.331 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 299.42 kN.

$$\frac{Vuy}{phiVny} = \frac{299.42}{6856.22} = 0.044 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 557.76 kN.

$$\frac{Vuz}{phiVnz} = \frac{557.76}{6094.42} = 0.092 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04442e+000,  Lz   = 1.04442e+000,  Lb   = 1.04442e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-774.88	-1130.85	-631.73	-433.15	-264.61
TOTAL	-774.88	-1130.85	-631.73	-433.15	-264.61

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 774.88 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2850044.09 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4689445.51 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-774.88	-631.73	-264.61
TOTAL	-774.88	-631.73	-264.61

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -631.73 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -264.61 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 2850044.0877 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.044 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8673e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 2850044.0877 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        125.17 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22693.98 kN.
           -. phiPn =  phi*Pn  =      20424.59 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              774.88
           -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20424.59

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{631.73}{2713.75} = 0.233 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{264.61}{3288.12} = 0.080 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.019 + [\ 0.233 + 0.080\ ]$$

$$= 0.332 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 293.56 kN.

$$\frac{Vuy}{phiVny} = \frac{293.56}{8273.17} = 0.035 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 594.56 kN.

$$\frac{Vuz}{phiVnz} = \frac{594.56}{6094.42} = 0.098 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105120,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78243e+000,  Lz   = 1.78243e+000,  Lb   = 1.78243e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3093.09	-846.34	-552.13	-276.82	-126.65
TOTAL	-3093.09	-846.34	-552.13	-276.82	-126.65

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3093.09 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 978535.03 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610075.69 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3093.09	-846.34	-276.82
TOTAL	-3093.09	-846.34	-276.82

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -846.34 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -276.82 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  978535.0308 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8445e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  978535.0308 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          42.97 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.31 kN.
          -. phiPn =  phi*Pn  =      20294.38 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3093.09
          -. -------  =  ---------------  =          0.15  <  1.000  --->  O.K.
              phiPn           20294.38

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               846.34
           -. --------  =  ---------------  =  0.312  <  1.000  --->  O.K.
               phiMny            2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               276.82
           -. --------  =  ---------------  =  0.084  <  1.000  --->  O.K.
               phiMnz            3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.076 + [  0.312  +  0.084 ]
                      =  0.472  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 280.62 kN.

$$\frac{Vuy}{phiVny} = \frac{280.62}{6856.22} = 0.041 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 315.34 kN.

$$\frac{Vuz}{phiVnz} = \frac{315.34}{6094.42} = 0.052 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105121,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04440e+000,  Lz   = 1.04440e+000,  Lb   = 1.04440e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3096.28	-715.30	-846.32	-463.44	-280.27
TOTAL	-3096.28	-715.30	-846.32	-463.44	-280.27

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3096.28 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2850156.44 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4689630.38 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3096.28	-846.32	-280.27
TOTAL	-3096.28	-846.32	-280.27

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -846.32 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -280.27 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2850156.4416 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.044 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8674e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2850156.4416 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.17 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.99 kN.
          -. phiPn =  phi*Pn  =      20424.59 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3096.28
          -. -------  =  ---------------  =          0.15  <  1.000  --->  O.K.
              phiPn           20424.59

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{846.32}{2713.75} = 0.312 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{280.27}{3288.12} = 0.085 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.076 + [\ 0.312 + 0.085\ ]$$

$$= 0.473 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 273.89 kN.

$$\frac{Vuy}{phiVny} = \frac{273.89}{8273.17} = 0.033 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 231.89 kN.

$$\frac{Vuz}{phiVnz} = \frac{231.89}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.14530e+000,  Lz   = 2.14530e+000,  Lb   = 2.14530e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1397.03	-547.42	-168.59	-235.41	-172.76
TOTAL	-1397.03	-547.42	-168.59	-235.41	-172.76

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1397.03 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.82
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1826
Pey = (Area*Fy)/Lambda^2 = 702339.81 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.39
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1373
Pez = (Area*Fy)/Lambda^2 = 1242905.39 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1397.03	-547.42	-235.41
TOTAL	-1397.03	-547.42	-235.41

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -547.42 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -235.41 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 13.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  702339.8077 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.145 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.4228e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  702339.8077 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          29.98 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23101.94 kN.
          -. phiPn =  phi*Pn  =      20791.75 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1397.03
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20791.75

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.90 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.90 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{547.42}{2819.90} = 0.194 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.43 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.43 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.43 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{235.41}{3511.43} = 0.067 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.034 + [\ 0.194 + 0.067\ ]$$

$$= 0.295 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 194.64 kN.

$$\text{Vuy} / \text{phiVny} = 194.64 / 6856.22 = 0.028 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 262.52 kN.

$$\text{Vuz} / \text{phiVnz} = 262.52 / 6094.42 = 0.043 < 1.000 \text{ ---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.21874e-001,  Lz   = 8.21874e-001,  Lb   = 8.21874e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1414.98	-592.77	-547.63	-367.15	-239.41
TOTAL	-1414.98	-592.77	-547.63	-367.15	-239.41

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1414.98 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.29
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0700
Pey = (Area*Fy)/Lambda^2 = 4785359.49 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 3.98
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0526
Pez = (Area*Fy)/Lambda^2 = 8468477.87 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1414.98	-547.63	-239.41
TOTAL	-1414.98	-547.63	-239.41

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -547.63 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -239.41 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4785359.4857 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.822 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.3762e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4785359.4857 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        204.27 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23378.77 kN.
          -. phiPn =  phi*Pn  =      21040.89 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1414.98
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           21040.89

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2822.04 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2822.04 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               547.63
           -. --------  =  ---------------  =  0.194  <  1.000  --->  O.K.
               phiMny            2822.04

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               239.41
           -. --------  =  ---------------  =  0.068  <  1.000  --->  O.K.
               phiMnz            3515.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz   ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.034 + [  0.194  +  0.068 ]
                      =  0.296  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 186.92 kN.

$$\text{Vuy} / \text{phiVny} = 186.92 / 8654.07 = 0.022 < 1.000 \quad \text{---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 219.12 kN.

$$\text{Vuz} / \text{phiVnz} = 219.12 / 6094.42 = 0.036 < 1.000 \quad \text{---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 105140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.25880e+000,  Lz   = 2.25880e+000,  Lb   = 2.25880e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1662.97	-529.14	-225.83	-324.02	-143.56
TOTAL	-1662.97	-529.14	-225.83	-324.02	-143.56

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1662.97 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.55
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1923
Pey = (Area*Fy)/Lambda^2 = 633536.27 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.94
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1446
Pez = (Area*Fy)/Lambda^2 = 1121146.27 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1662.97	-529.14	-324.02
TOTAL	-1662.97	-529.14	-324.02

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -529.14 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -324.02 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  633536.2742 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.259 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.7936e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  633536.2742 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         27.04 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23066.94 kN.
          -. phiPn =  phi*Pn  =      20760.25 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1662.97
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20760.25

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.71 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.71 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{529.14}{2819.71} = 0.188 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.05 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.05 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.05 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{324.02}{3511.05} = 0.092 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.040 + [\ 0.188 + 0.092\ ]$$

$$= 0.320 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 205.48 kN.

$$\frac{Vuy}{phiVny} = \frac{205.48}{6856.22} = 0.030 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 261.60 kN.

$$\frac{Vuz}{phiVnz} = \frac{261.60}{6094.42} = 0.043 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 105141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.86699e-001,  Lz   = 9.86699e-001,  Lb   = 9.86699e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1674.84	-612.91	-529.02	-464.63	-329.72
TOTAL	-1674.84	-612.91	-529.02	-464.63	-329.72

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1674.84 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.36
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0840
Pey = (Area*Fy)/Lambda^2 = 3320138.24 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.78
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0631
Pez = (Area*Fy)/Lambda^2 = 5875528.75 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1674.84	-529.02	-329.72
TOTAL	-1674.84	-529.02	-329.72

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -529.02 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -329.72 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 3320138.2425 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.987 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.0362e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3320138.2425 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        141.72 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23357.64 kN.
          -. phiPn =  phi*Pn  =      21021.88 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1674.84
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21021.88

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.77 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.77 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{529.02}{2821.77} = 0.187 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.30 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.30 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.30 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{329.72}{3515.30} = 0.094 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.040 + [\ 0.187 + 0.094\ ]$$

$$= 0.321 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 196.60 kN.

$$\frac{Vuy}{phiVny} = \frac{196.60}{8654.07} = 0.023 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 204.13 kN.

$$\frac{Vuz}{phiVnz} = \frac{204.13}{6094.42} = 0.033 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 105201,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =    16
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-3.0_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.975,  Flg Width   =      0.975,  Web Center  =      0.937
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.42784e-001,  Asy  = 7.42950e-002,  Asz  = 7.42950e-002
         Ybar = 4.87500e-001,  Zbar = 4.87500e-001,  Qyb  = 3.29350e-001,  Qzb  = 3.29350e-001
         Syy  = 4.29197e-002,  Szz  = 4.29197e-002,  Zyy  = 5.01929e-002,  Zzz  = 5.01929e-002
         Iyy  = 2.09233e-002,  Izz  = 2.09233e-002,  Iyz  = 0.00000e+000
         ry   = 3.82804e-001,  rz   = 3.82804e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 3.30000e+000,  Lz   = 3.30000e+000,  Lb   = 3.30000e+000
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3175.09	-618.26	-2050.24	-1639.34	-2149.79
TOTAL	-3175.09	-618.26	-2050.24	-1639.34	-2149.79

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3175.09 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 22.68
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.2997
Pey = (Area*Fy)/Lambda^2 = 416353.13 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.86
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 22.68
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.2997
Pez = (Area*Fy)/Lambda^2 = 416353.13 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.86
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3175.09	-2050.24	-2149.79
TOTAL	-3175.09	-2050.24	-2149.79

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -2050.24 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -2149.79 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 22.7 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  416353.1345 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      3.300 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.0696e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  416353.1345 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          11.13 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       36021.68 kN.
          -. phiPn =  phi*Pn  =      32419.51 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3175.09
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn            32419.51

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       8435.66 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       8435.66 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy              2050.24
           -. --------  =  ---------------  =  0.243  <  1.000  --->  O.K.
               phiMny             8435.66

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       8435.66 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       8435.66 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       8435.66 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz              2149.79
           -. --------  =  ---------------  =  0.255  <  1.000  --->  O.K.
               phiMnz             8435.66

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.049 + [  0.243  +  0.255 ]
                      =  0.547  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 1104.83 kN.

$$\text{Vuy} / \text{phiVny} = 1104.83 / 11427.03 = 0.097 < 1.000 \quad \text{---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuz = 598.58 kN.

$$\text{Vuz} / \text{phiVnz} = 598.58 / 11427.03 = 0.052 < 1.000 \quad \text{---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 105210,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78240e+000,  Lz   = 1.78240e+000,  Lb   = 1.78240e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3136.12	-881.54	-545.24	-236.29	-154.96
TOTAL	-3136.12	-881.54	-545.24	-236.29	-154.96

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3136.12 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 978561.21 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610118.77 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3136.12	-881.54	-236.29
TOTAL	-3136.12	-881.54	-236.29

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -881.54 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -236.29 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  978561.2117 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8447e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  978561.2117 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          42.98 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.31 kN.
          -. phiPn =  phi*Pn  =      20294.38 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3136.12
          -. -------  =  ---------------  =          0.15  <  1.000  --->  O.K.
              phiPn           20294.38

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2712.54 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2712.54 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{881.54}{2712.54} = 0.325 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3285.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3285.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3285.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{236.29}{3285.85} = 0.072 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.077 + [\ 0.325 + 0.072\ ]$$

$$= 0.474 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 285.30 kN.

$$\frac{Vuy}{phiVny} = \frac{285.30}{6856.22} = 0.042 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 341.00 kN.

$$\frac{Vuz}{phiVnz} = \frac{341.00}{6094.42} = 0.056 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 105211,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04442e+000,  Lz   = 1.04442e+000,  Lb   = 1.04442e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


================================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3141.79	-769.41	-881.48	-442.74	-241.83
TOTAL	-3141.79	-769.41	-881.48	-442.74	-241.83

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3141.79 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2850044.09 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4689445.51 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3141.79	-881.48	-241.83
TOTAL	-3141.79	-881.48	-241.83

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -881.48 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -241.83 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2850044.0877 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.044 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8673e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2850044.0877 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.17 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.98 kN.
          -. phiPn =  phi*Pn  =      20424.59 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3141.79
          -. -------  =  ---------------  =          0.15  <  1.000  --->  O.K.
              phiPn           20424.59

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                881.48
           -. --------  =  ---------------  =  0.325  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                241.83
           -. --------  =  ---------------  =  0.074  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.077 + [  0.325  +  0.074 ]
                      =  0.475  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 279.15 kN.

$$\frac{Vuy}{phiVny} = \frac{279.15}{8273.17} = 0.034 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 231.61 kN.

$$\frac{Vuz}{phiVnz} = \frac{231.61}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 105220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78243e+000,  Lz   = 1.78243e+000,  Lb   = 1.78243e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-839.75	-671.40	-572.36	-280.27	-72.51
TOTAL	-839.75	-671.40	-572.36	-280.27	-72.51

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 839.75 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 978535.03 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 9.00
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1610075.69 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-839.75	-671.40	-280.27
TOTAL	-839.75	-671.40	-280.27

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -671.40 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -280.27 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  978535.0308 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8445e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  978535.0308 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          42.97 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.31 kN.
          -. phiPn =  phi*Pn  =      20294.38 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               839.75
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20294.38

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                671.40
           -. --------  =  ---------------  =  0.248  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                280.27
           -. --------  =  ---------------  =  0.085  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.021 + [  0.248  +  0.085 ]
                      =  0.353  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 312.25 kN.

$$\frac{Vuy}{phiVny} = \frac{312.25}{6856.22} = 0.046 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 594.69 kN.

$$\frac{Vuz}{phiVnz} = \frac{594.69}{6094.42} = 0.098 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04442e+000,  Lz   = 1.04442e+000,  Lb   = 1.04442e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-890.87	-1194.56	-671.42	-524.06	-286.28
TOTAL	-890.87	-1194.56	-671.42	-524.06	-286.28

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 890.87 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2850044.09 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4689445.51 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-890.87	-671.42	-286.28
TOTAL	-890.87	-671.42	-286.28

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -671.42 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -286.28 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  22769.9982 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                       pi^2 * E
           -. Pe_FB = -----------Area  = 2850044.0877 kN.
                       (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.044 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8673e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 2850044.0877 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        125.17 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       22693.98 kN.
           -. phiPn =  phi*Pn  =      20424.59 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              890.87
           -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20424.59

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{671.42}{2713.75} = 0.247 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{286.28}{3288.12} = 0.087 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.022 + [\ 0.247 + 0.087\ ]$$

$$= 0.356 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 306.40 kN.

$$\frac{Vuy}{phiVny} = \frac{306.40}{8273.17} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 625.39 kN.

$$\frac{Vuz}{phiVnz} = \frac{625.39}{6094.42} = 0.103 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.19616e+000,  Lz   = 2.19616e+000,  Lb   = 2.19616e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1404.27	-567.35	-206.72	-155.44	-145.88
TOTAL	-1404.27	-567.35	-206.72	-155.44	-145.88

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1404.27 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.15
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1870
Pey = (Area*Fy)/Lambda^2 = 670189.48 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.63
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1405
Pez = (Area*Fy)/Lambda^2 = 1186010.12 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1404.27	-567.35	-155.44
TOTAL	-1404.27	-567.35	-155.44

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -567.35 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -155.44 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  670189.4812 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.196 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.1288e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  670189.4812 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          28.61 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23086.47 kN.
          -. phiPn =  phi*Pn  =      20777.83 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1404.27
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20777.83

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.82 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.82 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{567.35}{2819.82} = 0.201 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.26 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.26 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.26 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{155.44}{3511.26} = 0.044 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.034 + [\ 0.201 + 0.044\ ]$$

$$= 0.279 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 204.73 kN.

$$\frac{Vuy}{phiVny} = \frac{204.73}{6856.22} = 0.030 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 273.66 kN.

$$\frac{Vuz}{phiVnz} = \frac{273.66}{6094.42} = 0.045 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.37118e-001,  Lz   = 8.37118e-001,  Lb   = 8.37118e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1423.10	-615.29	-567.16	-253.41	-158.94
TOTAL	-1423.10	-615.29	-567.16	-253.41	-158.94

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1423.10 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.39
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0713
Pey = (Area*Fy)/Lambda^2 = 4612667.09 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.05
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0536
Pez = (Area*Fy)/Lambda^2 = 8162870.38 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1423.10	-567.16	-158.94
TOTAL	-1423.10	-567.16	-158.94

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -567.16 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -158.94 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4612667.0947 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.837 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.2182e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4612667.0947 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        196.90 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23376.98 kN.
          -. phiPn =  phi*Pn  =      21039.28 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1423.10
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           21039.28

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2822.01 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2822.01 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{567.16}{2822.01} = 0.201 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.80 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.80 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.80 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{158.94}{3515.80} = 0.045 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.034 + [\ 0.201 + 0.045\ ]$$

$$= 0.280 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 199.09 kN.

$$\frac{Vuy}{phiVny} = \frac{199.09}{8654.07} = 0.023 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 232.00 kN.

$$\frac{Vuz}{phiVnz} = \frac{232.00}{6094.42} = 0.038 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 105240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.30779e+000,  Lz   = 2.30779e+000,  Lb   = 2.30779e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1687.70	-520.09	-251.35	-321.86	-141.37
TOTAL	-1687.70	-520.09	-251.35	-321.86	-141.37

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1687.70 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.86
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1965
Pey = (Area*Fy)/Lambda^2 = 606923.45 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.17
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1477
Pez = (Area*Fy)/Lambda^2 = 1074050.52 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1687.70	-520.09	-321.86
TOTAL	-1687.70	-520.09	-321.86

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -520.09 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -321.86 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.9 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  606923.4536 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.308 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.5503e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  606923.4536 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          25.91 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23051.29 kN.
          -. phiPn =  phi*Pn  =      20746.16 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1687.70
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20746.16

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.64 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.64 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                520.09
           -. --------  =  ---------------  =  0.184  <  1.000  --->  O.K.
               phiMny             2819.64

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3510.89 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3510.89 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3510.89 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                321.86
           -. --------  =  ---------------  =  0.092  <  1.000  --->  O.K.
               phiMnz             3510.89

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.041 + [  0.184  +  0.092 ]
                      =  0.317  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 214.71 kN.

$$\frac{Vuy}{phiVny} = \frac{214.71}{6856.22} = 0.031 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 247.93 kN.

$$\frac{Vuz}{phiVnz} = \frac{247.93}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 105241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.00449e+000,  Lz   = 1.00449e+000,  Lb   = 1.00449e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1698.37	-592.14	-520.37	-468.38	-327.36
TOTAL	-1698.37	-592.14	-520.37	-468.38	-327.36

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1698.37 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.47
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0855
Pey = (Area*Fy)/Lambda^2 = 3203564.98 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.86
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0643
Pez = (Area*Fy)/Lambda^2 = 5669233.26 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1698.37	-520.37	-327.36
TOTAL	-1698.37	-520.37	-327.36

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -520.37 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -327.36 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 3203564.9809 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.004 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.9296e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3203564.9809 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        136.75 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23355.13 kN.
          -. phiPn =  phi*Pn  =      21019.62 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1698.37
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21019.62

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.74 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.74 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{520.37}{2821.74} = 0.184 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.24 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.24 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.24 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{327.36}{3515.24} = 0.093 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.040 + [\ 0.184 + 0.093\ ]$$

$$= 0.318 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 210.97 kN.

$$\frac{Vuy}{phiVny} = \frac{210.97}{8654.07} = 0.024 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 205.08 kN.

$$\frac{Vuz}{phiVnz} = \frac{205.08}{6094.42} = 0.034 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 106001,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    19
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-4.5_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      1.088,  Flg Width   =      1.088,  Web Center  =      1.050
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.60005e-001,  Asy  = 8.29056e-002,  Asz  = 8.29056e-002
         Ybar = 5.44000e-001,  Zbar = 5.44000e-001,  Qyb  = 4.13540e-001,  Qzb  = 4.13540e-001
         Syy  = 5.41066e-002,  Szz  = 5.41066e-002,  Zyy  = 6.30235e-002,  Zzz  = 6.30235e-002
         Iyy  = 2.94340e-002,  Izz  = 2.94340e-002,  Iyz  = 0.00000e+000
         ry   = 4.28902e-001,  rz   = 4.28902e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 4.00000e+000,  Lz   = 4.00000e+000,  Lb   = 4.00000e+000
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2358.76	-596.48	-2743.39	-707.42	-606.77
TOTAL	-2358.76	-596.48	-2743.39	-707.42	-606.77

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2358.76 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 27.49
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.3633
Pey = (Area*Fy)/Lambda^2 = 283380.35 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.86
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 27.49
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.3633
Pez = (Area*Fy)/Lambda^2 = 283380.35 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.86
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2358.76	-2743.39	-606.77
TOTAL	-2358.76	-2743.39	-606.77

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -2743.39 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -606.77 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 27.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  283380.3522 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      4.000 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 7.2801e+036 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  283380.3522 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =           7.58 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       35391.72 kN.
          -. phiPn =  phi*Pn  =      31852.55 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2358.76
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           31852.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       8432.89 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       8432.89 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy              2743.39
           -. --------  =  ---------------  =  0.325  <  1.000  --->  O.K.
               phiMny             8432.89

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       8432.89 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       8432.89 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       8432.89 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               606.77
           -. --------  =  ---------------  =  0.072  <  1.000  --->  O.K.
               phiMnz             8432.89

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.037 + [  0.325  +  0.072 ]
                      =  0.434  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 359.11 kN.

$$\frac{Vuy}{phiVny} = \frac{359.11}{11427.03} = 0.031 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 536.84 kN.

$$\frac{Vuz}{phiVnz} = \frac{536.84}{11427.03} = 0.047 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 106010,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   148-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78231e+000,  Lz   = 1.78231e+000,  Lb   = 1.78231e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =148-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1782.52	-356.83	-692.27	-114.35	-54.92
TOTAL	-1782.52	-356.83	-692.27	-114.35	-54.92

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1782.52 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 833985.70 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.73
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1418
Pez = (Area*Fy)/Lambda^2 = 1011462.62 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1782.52	-692.27	-54.92
TOTAL	-1782.52	-692.27	-54.92

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -692.27 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -54.92 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  833985.6995 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2331e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  833985.6995 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.03 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.67 kN.
          -. phiPn =  phi*Pn  =      18108.60 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1782.52
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           18108.60

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2310.95 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2310.95 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                692.27
           -. --------  =  ---------------  =  0.300  <  1.000  --->  O.K.
              phiMny             2310.95

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       2490.69 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       2490.69 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       2490.69 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                 54.92
           -. --------  =  ---------------  =  0.022  <  1.000  --->  O.K.
              phiMnz             2490.69

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.049 + [  0.300  +  0.022 ]
                      =  0.371  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 248.16 kN.

$$\frac{Vuy}{phiVny} = \frac{248.16}{6856.22} = 0.036 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 287.89 kN.

$$\frac{Vuz}{phiVnz} = \frac{287.89}{6094.42} = 0.047 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 106011,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04477e+000,  Lz   = 1.04477e+000,  Lb   = 1.04477e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1377.99	-178.75	-319.26	-666.67	-413.37
TOTAL	-1377.99	-178.75	-319.26	-666.67	-413.37

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1377.99 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848111.94 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686266.37 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1377.99	-319.26	-413.37
TOTAL	-1377.99	-319.26	-413.37

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -319.26 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -413.37 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848111.9411 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8653e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848111.9411 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.08 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1377.99
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2713.75 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2713.75 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{319.26}{2713.75} = 0.118 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3288.12 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3288.12 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3288.12 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{413.37}{3288.12} = 0.126 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.034 + [\ 0.118 + 0.126\ ]$$

$$= 0.277 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 242.47 kN.

$$\frac{Vuy}{phiVny} = \frac{242.47}{8273.17} = 0.029 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 442.33 kN.

$$\frac{Vuz}{phiVnz} = \frac{442.33}{6094.42} = 0.073 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 106020,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   148-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78152e+000,  Lz   = 1.78152e+000,  Lb   = 1.78152e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =148-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1835.59	-393.87	-681.91	-80.99	-44.47
TOTAL	-1835.59	-393.87	-681.91	-80.99	-44.47

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1835.59 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1561
Pey = (Area*Fy)/Lambda^2 = 834724.09 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.72
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1417
Pez = (Area*Fy)/Lambda^2 = 1012358.14 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1835.59	-681.91	-44.47
TOTAL	-1835.59	-681.91	-44.47

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -681.91 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -44.47 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.37 m.
-. DTRf = Dflg/tf = 9.81 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.059 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.37 m.
          -. DTRw  =  Dweb/tf   =    9.81  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.059 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  20326.9781 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  834724.0850 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 1.2341e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  834724.0850 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          41.06 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       20120.85 kN.
          -. phiPn =  phi*Pn  =      18108.76 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1835.59
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn           18108.76

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2310.95 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2310.95 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{681.91}{2310.95} = 0.295 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 2490.70 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 2490.70 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 2490.70 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{44.47}{2490.70} = 0.018 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.051 + [\ 0.295 + 0.018\ ]$$

$$= 0.364 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 250.91 kN.

$$\frac{Vuy}{phiVny} = \frac{250.91}{6856.22} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 264.43 kN.

$$\frac{Vuz}{phiVnz} = \frac{264.43}{6094.42} = 0.043 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106021,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04477e+000,  Lz   = 1.04477e+000,  Lb   = 1.04477e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1306.57	-208.34	-318.09	-637.08	-390.79
TOTAL	-1306.57	-208.34	-318.09	-637.08	-390.79

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1306.57 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2848111.94 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4686266.37 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1306.57	-318.09	-390.79
TOTAL	-1306.57	-318.09	-390.79

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -318.09 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -390.79 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2848111.9411 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8653e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2848111.9411 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.08 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.93 kN.
          -. phiPn =  phi*Pn  =      20424.54 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1306.57
          -. -------  =  ---------------  =          0.06  <  1.000  --->  O.K.
              phiPn           20424.54

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                318.09
           -. --------  =  ---------------  =  0.117  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                390.79
           -. --------  =  ---------------  =  0.119  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.032 + [  0.117  +  0.119 ]
                      =  0.268  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 244.50 kN.

$$\frac{Vuy}{phiVny} = \frac{244.50}{8273.17} = 0.030 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 426.08 kN.

$$\frac{Vuz}{phiVnz} = \frac{426.08}{6094.42} = 0.070 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106030,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.17032e+000,  Lz   = 2.17032e+000,  Lb   = 2.17032e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1459.65	-546.89	-234.54	-115.74	-73.38
TOTAL	-1459.65	-546.89	-234.54	-115.74	-73.38

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1459.65 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.98
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1848
Pey = (Area*Fy)/Lambda^2 = 686242.16 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.51
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1389
Pez = (Area*Fy)/Lambda^2 = 1214417.97 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1459.65	-546.89	-115.74
TOTAL	-1459.65	-546.89	-115.74

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      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =     -546.89 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =     -115.74 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AASHTO-LRFD12 Specification 6.9.3 ]
           -. Kl/r  =    14.0  <   120.0  --->  O.K.

      ------------------------------------------------------------------------
      [*]  Calculate Qa about y-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  Cw - tw   =    0.49 m.
           -. DTRf  =  Dflg/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
           -. Dweb  =  H-tf1-tf2 =    0.32 m.
           -. DTRw  =  Dweb/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
           -. Qa1 =  A_eff/Area  =   1.000  (about y-axis).

      ------------------------------------------------------------------------
      [*]  Calculate Qa about z-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  H-tf1-tf2 =    0.32 m.
           -. DTRf  =  Dflg/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
```

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  686242.1598 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.170 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.2756e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  686242.1598 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          29.29 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23094.37 kN.
          -. phiPn =  phi*Pn  =      20784.94 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1459.65
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20784.94

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.86 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.86 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                546.89
           -. --------  =  ---------------  =  0.194  <  1.000  --->  O.K.
              phiMny             2819.86

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.35 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.35 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.35 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                115.74
           -. --------  =  ---------------  =  0.033  <  1.000  --->  O.K.
              phiMnz             3511.35

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.035 + [  0.194  +  0.033 ]
                      =  0.262  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuy = 61.62 kN.

$$\frac{Vuy}{phiVny} = \frac{61.62}{6856.22} = 0.009 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 303.38 kN.

$$\frac{Vuz}{phiVnz} = \frac{303.38}{6094.42} = 0.050 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 106031,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.29451e-001,  Lz   = 8.29451e-001,  Lb   = 8.29451e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1469.66	-563.19	-546.82	-144.71	-119.83
TOTAL	-1469.66	-563.19	-546.82	-144.71	-119.83

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1469.66 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.34
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0706
Pey = (Area*Fy)/Lambda^2 = 4698331.32 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.02
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0531
Pez = (Area*Fy)/Lambda^2 = 8314467.27 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1469.66	-546.82	-119.83
TOTAL	-1469.66	-546.82	-119.83

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -546.82 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -119.83 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4698331.3241 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.829 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.2966e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4698331.3241 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        200.55 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23377.88 kN.
          -. phiPn =  phi*Pn  =      21040.10 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1469.66
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           21040.10

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2822.03 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2822.03 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{546.82}{2822.03} = 0.194 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.83 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.83 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.83 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{119.83}{3515.83} = 0.034 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.035 + [\ 0.194 + 0.034\ ]$$

$$= 0.263 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuy = 63.24 kN.

$$\frac{Vuy}{phiVny} = \frac{63.24}{8654.07} = 0.007 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 273.79 kN.

$$\frac{Vuz}{phiVnz} = \frac{273.79}{6094.42} = 0.045 < 1.000 \text{ ---> O.K.}$$

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 106040,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.28239e+000,  Lz   = 2.28239e+000,  Lb   = 2.28239e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1435.68	-506.08	-233.26	-118.43	-57.53
TOTAL	-1435.68	-506.08	-233.26	-118.43	-57.53

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1435.68 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.70
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1943
Pey = (Area*Fy)/Lambda^2 = 620505.09 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.05
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1461
Pez = (Area*Fy)/Lambda^2 = 1098085.45 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1435.68	-506.08	-118.43
TOTAL	-1435.68	-506.08	-118.43

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -506.08 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -118.43 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.7 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  620505.0903 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.282 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.6745e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  620505.0903 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          26.49 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23059.44 kN.
          -. phiPn =  phi*Pn  =      20753.50 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1435.68
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20753.50

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.68 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.68 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{506.08}{2819.68} = 0.179 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3510.97 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3510.97 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3510.97 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{118.43}{3510.97} = 0.034 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.035 + [\ 0.179 + 0.034\ ]$$

$$= 0.248 < 1.000 \ ---> \ O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = J)
-. Applied shear force : Vuy = 59.58 kN.

$$\frac{Vuy}{phiVny} = \frac{59.58}{6856.22} = 0.009 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 279.11 kN.

$$\frac{Vuz}{phiVnz} = \frac{279.11}{6094.42} = 0.046 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 106041,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.97079e-001,  Lz   = 9.97079e-001,  Lb   = 9.97079e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1445.64	-580.93	-506.13	-161.26	-120.80
TOTAL	-1445.64	-580.93	-506.13	-161.26	-120.80

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1445.64 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.42
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0849
Pey = (Area*Fy)/Lambda^2 = 3251368.75 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.83
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0638
Pez = (Area*Fy)/Lambda^2 = 5753829.87 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1445.64	-506.13	-120.80
TOTAL	-1445.64	-506.13	-120.80

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -506.13 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -120.80 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3251368.7546 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.997 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.9733e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3251368.7546 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        138.79 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23356.18 kN.
          -. phiPn =  phi*Pn  =      21020.56 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1445.64
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           21020.56

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2821.76 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2821.76 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy               506.13
           -. --------  =  ---------------  =  0.179  <  1.000  --->  O.K.
               phiMny            2821.76

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.27 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.27 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.27 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz               120.80
           -. --------  =  ---------------  =  0.034  <  1.000  --->  O.K.
               phiMnz            3515.27

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz   ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.034 + [  0.179  +  0.034 ]
                      =  0.248  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148-, POS = J)
-. Applied shear force : Vuy = 63.00 kN.

$$\frac{Vuy}{phiVny} = \frac{63.00}{8654.07} = 0.007 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 247.45 kN.

$$\frac{Vuz}{phiVnz} = \frac{247.45}{6094.42} = 0.041 < 1.000 \quad ---> \quad O.K.$$

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============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 107101,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =    15
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-2.5_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.938,  Flg Width   =      0.938,  Web Center  =      0.900
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.37145e-001,  Asy  = 7.14756e-002,  Asz  = 7.14756e-002
         Ybar = 4.69000e-001,  Zbar = 4.69000e-001,  Qyb  = 3.03864e-001,  Qzb  = 3.03864e-001
         Syy  = 3.95386e-002,  Szz  = 3.95386e-002,  Zyy  = 4.63089e-002,  Zzz  = 4.63089e-002
         Iyy  = 1.85436e-002,  Izz  = 1.85436e-002,  Iyz  = 0.00000e+000
         ry   = 3.67712e-001,  rz   = 3.67712e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.35000e+000,  Lz   = 2.35000e+000,  Lb   = 2.35000e+000
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3352.81	-1115.20	-2396.33	-636.35	-1929.00
TOTAL	-3352.81	-1115.20	-2396.33	-636.35	-1929.00

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3352.81 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 16.15
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.2134
Pey = (Area*Fy)/Lambda^2 = 821020.49 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 16.15
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.2134
Pez = (Area*Fy)/Lambda^2 = 821020.49 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3352.81	-2396.33	-1929.00
TOTAL	-3352.81	-2396.33	-1929.00

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -2396.33 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -1929.00 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 16.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  821020.4862 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.350 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.1092e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  821020.4862 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          21.95 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       36695.46 kN.
          -. phiPn =  phi*Pn  =      33025.91 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3352.81
          -. -------  =  ---------------  =          0.10  <  1.000  --->  O.K.
              phiPn            33025.91

==============================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
==============================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 8439.42 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 8439.42 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{2396.33}{8439.42} = 0.284 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 8439.42 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 8439.42 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 8439.42 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{1929.00}{8439.42} = 0.229 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.051 + [\ 0.284 + 0.229\ ]$$

$$= 0.563 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 1205.33 kN.

$$\frac{Vuy}{phiVny} = \frac{1205.33}{11427.03} = 0.105 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 617.13 kN.

$$\frac{Vuz}{phiVnz} = \frac{617.13}{11427.03} = 0.054 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107110,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78164e+000,  Lz   = 1.78164e+000,  Lb   = 1.78164e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-904.43	-709.05	-611.50	-298.79	-48.50
TOTAL	-904.43	-709.05	-611.50	-298.79	-48.50

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 904.43 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979397.89 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611495.43 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-904.43	-709.05	-298.79
TOTAL	-904.43	-709.05	-298.79

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -709.05 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -298.79 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979397.8865 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.782 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8532e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979397.8865 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.01 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.50 kN.
          -. phiPn =  phi*Pn  =      20294.55 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               904.43
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20294.55

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                709.05
           -. --------  =  ---------------  =  0.261  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                298.79
           -. --------  =  ---------------  =  0.091  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.022 + [  0.261  +  0.091 ]
                      =  0.375  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 263.27 kN.

$$\frac{Vuy}{phiVny} = \frac{263.27}{6856.22} = 0.038 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 631.10 kN.

$$\frac{Vuz}{phiVnz} = \frac{631.10}{6094.42} = 0.104 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107111,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04457e+000,  Lz   = 1.04457e+000,  Lb   = 1.04457e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-961.32	-1262.61	-709.24	-528.03	-307.67
TOTAL	-961.32	-1262.61	-709.24	-528.03	-307.67

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 961.32 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.76
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2849236.97 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.27
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4688117.48 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-961.32	-709.24	-307.67
TOTAL	-961.32	-709.24	-307.67

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -709.24 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -307.67 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2849236.9672 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8665e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2849236.9672 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        125.13 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.96 kN.
          -. phiPn =  phi*Pn  =      20424.57 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              961.32
          -. -------  =  ---------------  =          0.05  <  1.000  --->  O.K.
              phiPn           20424.57

==============================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                709.24
           -. --------  =  ---------------  =  0.261  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                307.67
           -. --------  =  ---------------  =  0.094  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.024 + [  0.261  +  0.094 ]
                      =  0.378  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 257.31 kN.
Vuy 257.31
-. -------- = --------------- = 0.031 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 650.88 kN.
Vuz 650.88
-. -------- = --------------- = 0.107 < 1.000 ---> O.K.
phiVnz 6094.42

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      *. PROJECT     :
      *. MEMBER NO   = 107120,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78149e+000,  Lz   = 1.78149e+000,  Lb   = 1.78149e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3300.43	-923.87	-587.14	-268.79	-173.23
TOTAL	-3300.43	-923.87	-587.14	-268.79	-173.23

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3300.43 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979562.37 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611766.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3300.43	-923.87	-268.79
TOTAL	-3300.43	-923.87	-268.79

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -923.87 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -268.79 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 11.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  =  979562.3684 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.781 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8548e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979562.3684 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.02 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.54 kN.
          -. phiPn =  phi*Pn  =      20294.58 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3300.43
          -. -------  =  ---------------  =          0.16  <  1.000  --->  O.K.
              phiPn           20294.58

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                923.87
           -. --------  =  ---------------  =  0.341  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                268.79
           -. --------  =  ---------------  =  0.082  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.081 + [  0.341  +  0.082 ]
                      =  0.504  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 288.52 kN.

$$\frac{Vuy}{phiVny} = \frac{288.52}{6856.22} = 0.042 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 360.93 kN.

$$\frac{Vuz}{phiVnz} = \frac{360.93}{6094.42} = 0.059 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107121,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04517e+000,  Lz   = 1.04517e+000,  Lb   = 1.04517e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3305.04	-799.87	-923.96	-522.10	-275.07
TOTAL	-3305.04	-799.87	-923.96	-522.10	-275.07

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3305.04 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2845921.87 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4682662.83 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3305.04	-923.96	-275.07
TOTAL	-3305.04	-923.96	-275.07

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -923.96 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -275.07 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                     pi^2 * E
          -. Pe_FB = -----------Area  = 2845921.8659 kN.
                     (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8631e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2845921.8659 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        124.99 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.87 kN.
          -. phiPn =  phi*Pn  =      20424.49 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3305.04
          -. -------  =  ---------------  =          0.16  <  1.000  --->  O.K.
              phiPn           20424.49

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                923.96
           -. --------  =  ---------------  =  0.340  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                275.07
           -. --------  =  ---------------  =  0.084  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.081 + [  0.340  +  0.084 ]
                      =  0.505  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 283.38 kN.
Vuy 283.38
-. -------- = --------------- = 0.034 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 237.23 kN.
Vuz 237.23
-. -------- = --------------- = 0.039 < 1.000 ---> O.K.
phiVnz 6094.42

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
==========================================================================================

      *. PROJECT     :
      *. MEMBER NO   = 107130,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.14453e+000,  Lz   = 2.14453e+000,  Lb   = 2.14453e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


==========================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
==========================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1433.54	-518.01	-334.56	-467.37	-63.69
TOTAL	-1433.54	-518.01	-334.56	-467.37	-63.69

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1433.54 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 13.81
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1826
Pey = (Area*Fy)/Lambda^2 = 702846.36 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.38
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1372
Pez = (Area*Fy)/Lambda^2 = 1243801.83 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1433.54	-518.01	-467.37
TOTAL	-1433.54	-518.01	-467.37

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -518.01 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -467.37 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 13.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  702846.3643 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.145 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.4275e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  702846.3643 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          30.00 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23102.17 kN.
          -. phiPn =  phi*Pn  =      20791.95 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1433.54
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20791.95

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2819.90 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2819.90 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{518.01}{2819.90} = 0.184 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3511.43 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3511.43 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3511.43 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{467.37}{3511.43} = 0.133 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.034 + [\ 0.184 + 0.133\ ]$$

$$= 0.351 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 217.76 kN.

$$\frac{Vuy}{phiVny} = \frac{217.76}{6856.22} = 0.032 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 345.96 kN.

$$\frac{Vuz}{phiVnz} = \frac{345.96}{6094.42} = 0.057 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107131,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.21709e-001,  Lz   = 8.21709e-001,  Lb   = 8.21709e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1454.93	-603.27	-516.01	-649.70	-482.09
TOTAL	-1454.93	-603.27	-516.01	-649.70	-482.09

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1454.93 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.29
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0700
Pey = (Area*Fy)/Lambda^2 = 4787280.13 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 3.98
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0526
Pez = (Area*Fy)/Lambda^2 = 8471876.77 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1454.93	-516.01	-482.09
TOTAL	-1454.93	-516.01	-482.09

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -516.01 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -482.09 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.3 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4787280.1327 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.822 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.3779e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4787280.1327 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        204.35 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23378.79 kN.
          -. phiPn =  phi*Pn  =      21040.91 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1454.93
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           21040.91

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2822.04 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2822.04 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{516.01}{2822.04} = 0.183 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.85 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.85 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.85 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{482.09}{3515.85} = 0.137 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.035 + [\ 0.183 + 0.137\ ]$$

$$= 0.355 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 207.32 kN.

$$\frac{Vuy}{phiVny} = \frac{207.32}{8654.07} = 0.024 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 308.14 kN.

$$\frac{Vuz}{phiVnz} = \frac{308.14}{6094.42} = 0.051 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107140,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.25796e+000,  Lz   = 2.25796e+000,  Lb   = 2.25796e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1653.98	-506.02	-289.02	-305.06	-220.85
TOTAL	-1653.98	-506.02	-289.02	-305.06	-220.85

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1653.98 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1922
Pey = (Area*Fy)/Lambda^2 = 634007.48 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.93
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1445
Pez = (Area*Fy)/Lambda^2 = 1121980.14 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1653.98	-506.02	-305.06
TOTAL	-1653.98	-506.02	-305.06

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -506.02 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -305.06 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  634007.4783 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.258 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.7979e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  634007.4783 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          27.06 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23067.20 kN.
          -. phiPn =  phi*Pn  =      20760.48 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1653.98
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20760.48

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.72 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.72 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                506.02
           -. --------  =  ---------------  =  0.179  <  1.000  --->  O.K.
               phiMny             2819.72

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.06 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.06 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.06 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                305.06
           -. --------  =  ---------------  =  0.087  <  1.000  --->  O.K.
               phiMnz             3511.06

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.040 + [  0.179  +  0.087 ]
                      =  0.306  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 255.25 kN.

$$\frac{Vuy}{phiVny} = \frac{255.25}{6856.22} = 0.037 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 218.91 kN.

$$\frac{Vuz}{phiVnz} = \frac{218.91}{6094.42} = 0.036 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107141,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 9.88841e-001,  Lz   = 9.88841e-001,  Lb   = 9.88841e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1659.19	-515.78	-506.76	-523.40	-305.43
TOTAL	-1659.19	-515.78	-506.76	-523.40	-305.43

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1659.19 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.37
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0842
Pey = (Area*Fy)/Lambda^2 = 3305768.50 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.79
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0633
Pez = (Area*Fy)/Lambda^2 = 5850099.12 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1659.19	-506.76	-305.43
TOTAL	-1659.19	-506.76	-305.43

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -506.76 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -305.43 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 3305768.4953 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.989 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 3.0231e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 3305768.4953 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        141.11 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23357.34 kN.
          -. phiPn =  phi*Pn  =      21021.61 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1659.19
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           21021.61

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2821.77 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2821.77 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                506.76
           -. --------  =  ---------------  =  0.180  <  1.000  --->  O.K.
               phiMny             2821.77

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3515.30 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3515.30 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3515.30 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                305.43
           -. --------  =  ---------------  =  0.087  <  1.000  --->  O.K.
               phiMnz             3515.30

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.039 + [  0.180  +  0.087 ]
                      =  0.306  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 248.42 kN.

$$\frac{Vuy}{phiVny} = \frac{248.42}{8654.07} = 0.029 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 191.93 kN.

$$\frac{Vuz}{phiVnz} = \frac{191.93}{6094.42} = 0.031 < 1.000 \quad ---> \quad O.K.$$

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============================================================================================


      *. PROJECT     :
      *. MEMBER NO   = 107201,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =    15
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = F_0.0-2.5_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.938,  Flg Width   =      0.938,  Web Center  =      0.900
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.750,  Flg Width   =      0.750,  Web Center  =      0.712
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001
        <Pos I>.
         Area = 1.37145e-001,  Asy  = 7.14756e-002,  Asz  = 7.14756e-002
         Ybar = 4.69000e-001,  Zbar = 4.69000e-001,  Qyb  = 3.03864e-001,  Qzb  = 3.03864e-001
         Syy  = 3.95386e-002,  Szz  = 3.95386e-002,  Zyy  = 4.63089e-002,  Zzz  = 4.63089e-002
         Iyy  = 1.85436e-002,  Izz  = 1.85436e-002,  Iyz  = 0.00000e+000
         ry   = 3.67712e-001,  rz   = 3.67712e-001
        <Pos J>.
         Area = 1.08494e-001,  Asy  = 5.71500e-002,  Asz  = 5.71500e-002
         Ybar = 3.75000e-001,  Zbar = 3.75000e-001,  Qyb  = 1.90232e-001,  Qzb  = 1.90232e-001
         Syy  = 2.45076e-002,  Szz  = 2.45076e-002,  Zyy  = 2.89914e-002,  Zzz  = 2.89914e-002
         Iyy  = 9.19037e-003,  Izz  = 9.19037e-003,  Iyz  = 0.00000e+000
         ry   = 2.91048e-001,  rz   = 2.91048e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.35000e+000,  Lz   = 2.35000e+000,  Lb   = 2.35000e+000
         Ky   = 2.00000e+000,  Kz   = 2.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-2919.30	-1094.02	-2492.85	-655.44	-1701.30
TOTAL	-2919.30	-1094.02	-2492.85	-655.44	-1701.30

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 0.850 (User defined or default value)
-. Cmz = 0.850 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 2919.30 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 16.15
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.2134
Pey = (Area*Fy)/Lambda^2 = 821020.49 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 0.85
B1y < 1.0 ---> B1y = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 16.15
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.2134
Pez = (Area*Fy)/Lambda^2 = 821020.49 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 0.85
B1z < 1.0 ---> B1z = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-2919.30	-2492.85	-1701.30
TOTAL	-2919.30	-2492.85	-1701.30

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -2492.85 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -1701.30 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 16.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.67 m.
-. DTRf = Dflg/tf = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.67 m.
-. DTRw = Dweb/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.108 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.67 m.
-. DTRf = Dflg/tw = 17.69 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.67 m.
          -. DTRw  =  Dweb/tf   =   17.69  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.108 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  37401.8498 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  821020.4862 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.350 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.1092e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  821020.4862 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          21.95 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       36695.46 kN.
          -. phiPn =  phi*Pn  =      33025.91 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              2919.30
          -. -------  =  ---------------  =          0.09  <  1.000  --->  O.K.
              phiPn           33025.91

=============================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       8439.42 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       8439.42 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy              2492.85
           -. --------  =  ---------------  =  0.295  <  1.000  --->  O.K.
               phiMny            8439.42

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       8439.42 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       8439.42 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       8439.42 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz              1701.30
           -. --------  =  ---------------  =  0.202  <  1.000  --->  O.K.
               phiMnz            8439.42

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.044 + [  0.295  +  0.202 ]
                      =  0.541  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 11427.03 kN.
-. Vny = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 1118.85 kN.

$$\text{Vuy} / \text{phiVny} = 1118.85 / 11427.03 = 0.098 < 1.000 \quad \text{---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 11427.03 kN.
-. Vnz = C*Vp = 11427.03 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 600.28 kN.

$$\text{Vuz} / \text{phiVnz} = 600.28 / 11427.03 = 0.053 < 1.000 \quad \text{---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 107210,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78149e+000,  Lz   = 1.78149e+000,  Lb   = 1.78149e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3070.63	-862.87	-598.18	-307.72	-110.47
TOTAL	-3070.63	-862.87	-598.18	-307.72	-110.47

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3070.63 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979562.37 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611766.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3070.63	-862.87	-307.72
TOTAL	-3070.63	-862.87	-307.72

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      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =     -862.87 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =     -307.72 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AASHTO-LRFD12 Specification 6.9.3 ]
           -. Kl/r  =    11.5  <   120.0  --->  O.K.

      ------------------------------------------------------------------------
      [*]  Calculate Qa about y-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  Cw - tw   =    0.47 m.
           -. DTRf  =  Dflg/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
           -. Dweb  =  H-tf1-tf2 =    0.32 m.
           -. DTRw  =  Dweb/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa1 =  A_eff/Area  =   1.000  (about y-axis).

      ------------------------------------------------------------------------
      [*]  Calculate Qa about z-axis (Sqaure and rectangular section).
      ------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  H-tf1-tf2 =    0.32 m.
           -. DTRf  =  Dflg/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
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          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979562.3684 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.781 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8548e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979562.3684 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.02 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.54 kN.
          -. phiPn =  phi*Pn  =      20294.58 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3070.63
          -. -------  =  ---------------  =          0.15  <  1.000  --->  O.K.
              phiPn           20294.58

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                862.87
           -. --------  =  ---------------  =  0.318  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                307.72
           -. --------  =  ---------------  =  0.094  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.076 + [  0.318  +  0.094 ]
                      =  0.487  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 280.51 kN.

$$\frac{Vuy}{phiVny} = \frac{280.51}{6856.22} = 0.041 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 327.49 kN.

$$\frac{Vuz}{phiVnz} = \frac{327.49}{6094.42} = 0.054 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107211,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04517e+000,  Lz   = 1.04517e+000,  Lb   = 1.04517e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-3072.19	-725.72	-862.91	-517.39	-311.56
TOTAL	-3072.19	-725.72	-862.91	-517.39	-311.56

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 3072.19 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2845921.87 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4682662.83 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-3072.19	-862.91	-311.56
TOTAL	-3072.19	-862.91	-311.56

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -862.91 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -311.56 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2845921.8659 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8631e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2845921.8659 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        124.99 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.87 kN.
          -. phiPn =  phi*Pn  =      20424.49 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              3072.19
          -. -------  =  ---------------  =          0.15  <  1.000  --->  O.K.
              phiPn           20424.49

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                862.91
           -. --------  =  ---------------  =  0.318  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                311.56
           -. --------  =  ---------------  =  0.095  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.075 + [  0.318  +  0.095 ]
                      =  0.488  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151-, POS = J)
-. Applied shear force : Vuy = 274.47 kN.

$$\frac{Vuy}{phiVny} = \frac{274.47}{8273.17} = 0.033 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 243.33 kN.

$$\frac{Vuz}{phiVnz} = \frac{243.33}{6094.42} = 0.040 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107220,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   173
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.78149e+000,  Lz   = 1.78149e+000,  Lb   = 1.78149e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
```

( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-840.59	-661.77	-558.03	-293.97	-81.64
TOTAL	-840.59	-661.77	-558.03	-293.97	-81.64

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 840.59 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 11.54
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1525
Pey = (Area*Fy)/Lambda^2 = 979562.37 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 8.99
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1189
Pez = (Area*Fy)/Lambda^2 = 1611766.07 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-840.59	-661.77	-293.97
TOTAL	-840.59	-661.77	-293.97

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      ( ). Compute magnified moments.
           -. Muy   =  B1y*My(DL+LL) + B2y*My(OTHERS) =     -661.77 kN-m.
           -. Muz   =  B1z*Mz(DL+LL) + B2z*Mz(OTHERS) =     -293.97 kN-m.

============================================================================================
   [[[*]]]   CHECK AXIAL STRENGTH.
============================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/r).
           [ AASHTO-LRFD12 Specification 6.9.3 ]
           -. Kl/r  =    11.5  <   120.0  --->  O.K.

      ----------------------------------------------------------------------------
      [*]  Calculate Qa about y-axis (Sqaure and rectangular section).
      ----------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  Cw - tw   =    0.47 m.
           -. DTRf  =  Dflg/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
           -. Dweb  =  H-tf1-tf2 =    0.32 m.
           -. DTRw  =  Dweb/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
           -. Qa1 =  A_eff/Area  =   1.000  (about y-axis).

      ----------------------------------------------------------------------------
      [*]  Calculate Qa about z-axis (Sqaure and rectangular section).
      ----------------------------------------------------------------------------

      ( ). Check width-thickness ratio of flange of box (BTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.40*SQRT[Es/Fy]  =   33.72
           -. Dflg  =  H-tf1-tf2 =    0.32 m.
           -. DTRf  =  Dflg/tw   =    8.50  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Check width-thickness ratio of web of box (DTR).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Lambda_r  =  1.49*SQRT[Es/Fy]  =   35.88
```

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  979562.3684 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.781 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 9.8548e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  979562.3684 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          43.02 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22549.54 kN.
          -. phiPn =  phi*Pn  =      20294.58 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu               840.59
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20294.58

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2712.54 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2712.54 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                661.77
           -. --------  =  ---------------  =  0.244  <  1.000  --->  O.K.
               phiMny             2712.54

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3285.85 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3285.85 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3285.85 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                293.97
           -. --------  =  ---------------  =  0.089  <  1.000  --->  O.K.
               phiMnz             3285.85

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.021 + [  0.244  +  0.089 ]
                      =  0.354  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 272.36 kN.

$$\frac{Vuy}{phiVny} = \frac{272.36}{6856.22} = 0.040 < 1.000 \text{ ---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = I)
-. Applied shear force : Vuz = 564.75 kN.

$$\frac{Vuz}{phiVnz} = \frac{564.75}{6094.42} = 0.093 < 1.000 \text{ ---> O.K.}$$

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      *. PROJECT     :
      *. MEMBER NO   = 107221,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   152-,  MATERIAL NO  =     3,  SECTION NO =   171
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Transv_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.640,  Flg Width   =      0.598,  Web Center  =      0.560
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.543,  Web Center  =      0.505
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001
        <Pos I>.
         Area = 8.85292e-002,  Asy  = 4.55676e-002,  Asz  = 4.87680e-002
         Ybar = 2.99000e-001,  Zbar = 3.20000e-001,  Qyb  = 1.29718e-001,  Qzb  = 1.23618e-001
         Syy  = 1.64707e-002,  Szz  = 1.58198e-002,  Zyy  = 1.97690e-002,  Zzz  = 1.88394e-002
         Iyy  = 5.27063e-003,  Izz  = 4.73011e-003,  Iyz  = 0.00000e+000
         ry   = 2.43999e-001,  rz   = 2.31149e-001
        <Pos J>.
         Area = 6.60502e-002,  Asy  = 4.13766e-002,  Asz  = 3.04800e-002
         Ybar = 2.71500e-001,  Zbar = 2.00000e-001,  Qyb  = 6.22337e-002,  Qzb  = 7.77278e-002
         Syy  = 7.87687e-003,  Szz  = 9.54736e-003,  Zyy  = 9.48442e-003,  Zzz  = 1.18457e-002
         Iyy  = 1.57537e-003,  Izz  = 2.59211e-003,  Iyz  = 0.00000e+000
         ry   = 1.54438e-001,  rz   = 1.98102e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.04517e+000,  Lz   = 1.04517e+000,  Lb   = 1.04517e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =152-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-860.56	-1159.46	-661.80	-481.63	-298.78
TOTAL	-860.56	-1159.46	-661.80	-481.63	-298.78

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 860.56 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.77
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0894
Pey = (Area*Fy)/Lambda^2 = 2845921.87 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 5.28
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0697
Pez = (Area*Fy)/Lambda^2 = 4682662.83 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-860.56	-661.80	-298.78
TOTAL	-860.56	-661.80	-298.78

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -661.80 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -298.78 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.8 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.47 m.
-. DTRf = Dflg/tf = 12.25 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.066 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.47 m.
          -. DTRw  =  Dweb/tf   =   12.25  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.066 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  22769.9982 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 2845921.8659 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      1.045 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.8631e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 2845921.8659 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        124.99 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       22693.87 kN.
          -. phiPn =  phi*Pn  =      20424.49 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              860.56
          -. -------  =  ---------------  =          0.04  <  1.000  --->  O.K.
              phiPn           20424.49

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2713.75 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2713.75 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                661.80
           -. --------  =  ---------------  =  0.244  <  1.000  --->  O.K.
               phiMny             2713.75

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3288.12 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3288.12 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3288.12 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                298.78
           -. --------  =  ---------------  =  0.091  <  1.000  --->  O.K.
               phiMnz             3288.12

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.021 + [  0.244  +  0.091 ]
                      =  0.356  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8273.17 kN.
-. Vny = C*Vp = 8273.17 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuy = 266.79 kN.
Vuy 266.79
-. -------- = --------------- = 0.032 < 1.000 ---> O.K.
phiVny 8273.17

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuz = 609.47 kN.
Vuz 609.47
-. -------- = --------------- = 0.100 < 1.000 ---> O.K.
phiVnz 6094.42

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      *. PROJECT     :
      *. MEMBER NO   = 107230,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.19577e+000,  Lz   = 2.19577e+000,  Lb   = 2.19577e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1520.76	-527.64	-293.45	-325.70	-176.25
TOTAL	-1520.76	-527.64	-293.45	-325.70	-176.25

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1520.76 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.14
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1869
Pey = (Area*Fy)/Lambda^2 = 670428.01 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 10.63
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1405
Pez = (Area*Fy)/Lambda^2 = 1186432.24 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1520.76	-527.64	-325.70
TOTAL	-1520.76	-527.64	-325.70

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -527.64 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -325.70 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.1 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

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          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  670428.0106 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.196 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 6.1310e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  670428.0106 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =         28.62 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23086.59 kN.
          -. phiPn =  phi*Pn  =      20777.93 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1520.76
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           20777.93

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.82 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.82 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                527.64
           -. --------  =  ---------------  =  0.187  <  1.000  --->  O.K.
              phiMny             2819.82

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3511.26 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3511.26 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3511.26 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                325.70
           -. --------  =  ---------------  =  0.093  <  1.000  --->  O.K.
              phiMnz             3511.26

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.037 + [  0.187  +  0.093 ]
                      =  0.316  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
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( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 165.19 kN.

$$\frac{Vuy}{phiVny} = \frac{165.19}{6856.22} = 0.024 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 288.99 kN.

$$\frac{Vuz}{phiVnz} = \frac{288.99}{6094.42} = 0.047 < 1.000 \quad ---> \quad O.K.$$

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      *. PROJECT     :
      *. MEMBER NO   = 107231,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 8.36777e-001,  Lz   = 8.36777e-001,  Lb   = 8.36777e-001
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1532.57	-555.57	-527.74	-431.44	-336.03
TOTAL	-1532.57	-555.57	-527.74	-431.44	-336.03

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1532.57 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 5.39
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0712
Pey = (Area*Fy)/Lambda^2 = 4616428.67 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.05
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0535
Pez = (Area*Fy)/Lambda^2 = 8169527.09 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1532.57	-527.74	-336.03
TOTAL	-1532.57	-527.74	-336.03

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -527.74 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -336.03 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 5.4 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  = 4616428.6653 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      0.837 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 4.2217e+038 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  = 4616428.6653 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =          0.90
          -. Pe/Po =        197.06 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23377.02 kN.
          -. phiPn =  phi*Pn  =      21039.32 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1532.57
          -. -------  =  ---------------  =          0.07  <  1.000  --->  O.K.
              phiPn           21039.32

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2822.01 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2822.01 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{527.74}{2822.01} = 0.187 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.80 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.80 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.80 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{336.03}{3515.80} = 0.096 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.036 + [\ 0.187 + 0.096\ ]$$

$$= 0.319 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152+, POS = J)
-. Applied shear force : Vuy = 160.36 kN.

$$\text{Vuy} / \text{phiVny} = 160.36 / 8654.07 = 0.019 < 1.000 \quad \text{---> O.K.}$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 259.28 kN.

$$\text{Vuz} / \text{phiVnz} = 259.28 / 6094.42 = 0.043 < 1.000 \quad \text{---> O.K.}$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                          Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107240,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   174
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Sup_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos I> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.450,  Web Center  =      0.412
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos I> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos J>.
         Area = 5.89636e-002,  Asy  = 3.42900e-002,  Asz  = 3.04800e-002
         Ybar = 2.25000e-001,  Zbar = 2.00000e-001,  Qyb  = 5.38196e-002,  Qzb  = 5.86558e-002
         Syy  = 6.71240e-003,  Szz  = 7.23630e-003,  Zyy  = 8.20210e-003,  Zzz  = 8.93914e-003
         Iyy  = 1.34248e-003,  Izz  = 1.62817e-003,  Iyz  = 0.00000e+000
         ry   = 1.50891e-001,  rz   = 1.66172e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 2.30656e+000,  Lz   = 2.30656e+000,  Lb   = 2.30656e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


================================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
================================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1670.12	-491.90	-261.24	-275.30	-177.74
TOTAL	-1670.12	-491.90	-261.24	-275.30	-177.74

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1670.12 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 14.86
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.1964
Pey = (Area*Fy)/Lambda^2 = 607569.60 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 11.17
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.1476
Pez = (Area*Fy)/Lambda^2 = 1075193.97 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <I>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1670.12	-491.90	-275.30
TOTAL	-1670.12	-491.90	-275.30

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -491.90 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -275.30 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 14.9 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

     ( ). Calculate reduction factor of stiffened elements (Qa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
          -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

     ( ). Calculate reduction factor of stiffened elements (Qa).
          -. Qa  =  1.0 (Stiffened elements are not Slender.)

     ( ). Full reduction factor for slender section (QsQa).
          [ AASHTO-LRFD12 Specification 6.9.4.2 ]
          -. Q  =  Qs*Qa  =   1.000

          -. Po  =  Q*Fy*Area  =  23426.7240 kN.

     ( ). Calculate Flexural Buckling Resistance (Pe_FB).
          [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
          -. Pe_FB = -----------Area  =  607569.5958 kN.
                      (Kl/r)^2

     ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
          [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
          -. Doubly symmetric shape
          -. Gs   =  7.6903e+007 KPa.
          -. Kx   =      1.00 (Conservatively taken value).
          -. L    =      2.307 m.
          -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 5.5562e+037 kN.

     ( ).  Elastic Critical Buckling Resistance (Pe).
          -. Pe = min[Pe_FB, Pe_FTB ]  =  607569.5958 kN.

     ( ). Calculate axial compressive strength (phiPn).
          [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
          -. phi   =           0.90
          -. Pe/Po =          25.93 >= 0.44
          -. Pn    = [0.658^(Po/Pe)]*Po =       23051.69 kN.
          -. phiPn =  phi*Pn  =      20746.52 kN.

     ( ). Check ratio of axial strength (Pu/phiPn).
               Pu              1670.12
          -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn           20746.52

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
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============================================================================================


      ( ). Compute nominal flexural strength(Mny).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mny  =  Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5]  =       2819.64 kN-m.

      ( ). Compute flexural strength about major axis (phiMny).
           [ AASHTO-LRFD12 Specification 6.12.1.2.1-1 ]
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMny  =  phi*Mny  =       2819.64 kN-m.

      ( ). Check ratio of flexural strength (Muy/phiMny).
                Muy                491.90
           -. --------  =  ---------------  =  0.174  <  1.000  --->  O.K.
               phiMny             2819.64

============================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.
============================================================================================

      ( ). Compute nominal flexural strength(Mnz).
           [ AASHTO-LRFD12 Specification 6.12.2.2.2-1]
           -. Mnz  =  Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5]  =       3510.89 kN-m.

      ( ). Compute flexural strength about minor axis (phiMnz).
           -. Mnz  =       3510.89 kN-m.
           -. Resistance factor for flexure  :  phi = 1.00
           -. phiMnz  =  phi*Mnz  =       3510.89 kN-m.

      ( ). Check ratio of flexural strength (Muz/phiMnz).
                Muz                275.30
           -. --------  =  ---------------  =  0.078  <  1.000  --->  O.K.
               phiMnz             3510.89

============================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED STRENGTH.
============================================================================================

      ( ). Check interaction ratio of combined strength.
           [ AASHTO-LRFD12 Specification 6.9.2.2 ]
           -. Pu/phiPn  <  0.20  --->  Formula(6.9.2.2-2)
                            Pu       [    Muy        Muz    ]
           -. ComRat  =  --------- + [ -------- + -------- ]
                          2*phiPn    [  phiMny     phiMnz  ]
                      =  0.040 + [  0.174  +  0.078 ]
                      =  0.293  <  1.000  --->  O.K.

============================================================================================
   [[[*]]]   CHECK SHEAR STRENGTH.
============================================================================================
```

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 6856.22 kN.
-. Vny = C*Vp = 6856.22 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 193.96 kN.

$$\frac{Vuy}{phiVny} = \frac{193.96}{6856.22} = 0.028 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 151+, POS = J)
-. Applied shear force : Vuz = 222.43 kN.

$$\frac{Vuz}{phiVnz} = \frac{222.43}{6094.42} = 0.036 < 1.000 \quad ---> \quad O.K.$$

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 MIDAS/Civil - Steel Code Checking [ AASHTO-LRFD12 ]                        Version 8.8.5
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      *. PROJECT     :
      *. MEMBER NO   = 107241,  ELEMENT TYPE = Beam
      *. LOADCOMB NO =   151-,  MATERIAL NO  =     3,  SECTION NO =   172
      *. UNIT SYSTEM : kN, m

      *. SECTION PROPERTIES : Designation = R_Long_Inf_(1-1/2")
         Shape     = B - Section. (Tapered)
        <Pos J> (Checking Position).
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos I>.
         Depth     =      0.580,  Flg Width   =      0.615,  Web Center  =      0.577
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038
        <Pos J>.
         Depth     =      0.400,  Flg Width   =      0.568,  Web Center  =      0.530
         Web Thick =      0.038,  Top F Thick =      0.038,  Bot.F Thick =      0.038

        <Pos J> (Checking Position).
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001
        <Pos I>.
         Area = 8.52526e-002,  Asy  = 4.68630e-002,  Asz  = 4.41960e-002
         Ybar = 3.07500e-001,  Zbar = 2.90000e-001,  Qyb  = 1.15044e-001,  Qzb  = 1.19939e-001
         Syy  = 1.46829e-002,  Szz  = 1.52060e-002,  Zyy  = 1.75327e-002,  Zzz  = 1.82787e-002
         Iyy  = 4.25805e-003,  Izz  = 4.67585e-003,  Iyz  = 0.00000e+000
         ry   = 2.23487e-001,  rz   = 2.34194e-001
        <Pos J>.
         Area = 6.79552e-002,  Asy  = 4.32816e-002,  Asz  = 3.04800e-002
         Ybar = 2.84000e-001,  Zbar = 2.00000e-001,  Qyb  = 6.44956e-002,  Qzb  = 8.32234e-002
         Syy  = 8.18989e-003,  Szz  = 1.02066e-002,  Zyy  = 9.82913e-003,  Zzz  = 1.26832e-002
         Iyy  = 1.63798e-003,  Izz  = 2.89867e-003,  Iyz  = 0.00000e+000
         ry   = 1.55254e-001,  rz   = 2.06532e-001

      *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
         Ly   = 1.00715e+000,  Lz   = 1.00715e+000,  Lb   = 1.00715e+000
         Ky   = 1.00000e+000,  Kz   = 1.00000e+000

      *. MATERIAL PROPERTIES :
         Fy   = 3.44738e+005,  Es   = 1.99948e+008,  MATERIAL NAME  = A709-50


============================================================================================
   [[[*]]]   COMPUTE MOMENT MAGNIFICATION FACTORS AND MAGNIFIED MOMENTS.
============================================================================================
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( ). Factored force/moments caused by unit load case.
*.Load combination ID =151-

Load Case	Pu	Myi	Myj	Mzi	Mzj
DL	0.00	0.00	0.00	0.00	0.00
LL	0.00	0.00	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00	0.00	0.00
OTHER CASES	-1678.38	-515.55	-491.89	-443.84	-279.25
TOTAL	-1678.38	-515.55	-491.89	-443.84	-279.25

*.Member end moments caused by gravity load(DL+LL).
My1G = 0.00, My2G = 0.00
Mz1G = 0.00, Mz2G = 0.00

( ). Compute equivalent moment factor (Cmy, Cmz).
-. Cmy = 1.000 (User defined or default value)
-. Cmz = 1.000 (User defined or default value)

( ). Compute moment magnification factors(B1y,B1z).
-. Pu = Pu(DL+LL) + Pu(WL(EL)) = 1678.38 kN.
-. About major(Local-y) axis.
SLENy = Ky*Ly/ry = 6.49
Lambda = (SLENy/pi)*SQRT(Fy/Es) = 0.0857
Pey = (Area*Fy)/Lambda^2 = 3186662.11 kN.
B1y = Cmy / (1-Pu/(0.9*Pey)) = 1.00
-. About minor(Local-z) axis.
SLENz = Kz*Lz/rz = 4.88
Lambda = (SLENz/pi)*SQRT(Fy/Es) = 0.0645
Pez = (Area*Fy)/Lambda^2 = 5639320.85 kN.
B1z = Cmz / (1-Pu/(0.9*Pez)) = 1.00

( ). Magnification factors for sidesway moments(B2y,B2z).
-. B2y = 1.00 (Default value)
-. B2z = 1.00 (Default value)

( ). Given factored axial forces and moments at <J>.

Load Case	Pu	My	Mz
DL	0.00	0.00	0.00
LL	0.00	0.00	0.00
DL+LL	0.00	0.00	0.00
OTHER CASES	-1678.38	-491.89	-279.25
TOTAL	-1678.38	-491.89	-279.25

( ). Compute magnified moments.
-. Muy = B1y*My(DL+LL) + B2y*My(OTHERS) = -491.89 kN-m.
-. Muz = B1z*Mz(DL+LL) + B2z*Mz(OTHERS) = -279.25 kN-m.

[[[*]]] CHECK AXIAL STRENGTH.

( ). Check slenderness ratio of axial compression member (Kl/r).
[AASHTO-LRFD12 Specification 6.9.3]
-. Kl/r = 6.5 < 120.0 ---> O.K.

[*] Calculate Qa about y-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = Cw - tw = 0.49 m.
-. DTRf = Dflg/tf = 12.91 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88
-. Dweb = H-tf1-tf2 = 0.32 m.
-. DTRw = Dweb/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Calculate reduction factor of stiffened elements (Qa).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. A_eff = Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw = 0.068 m^2.
-. Qa1 = A_eff/Area = 1.000 (about y-axis).

[*] Calculate Qa about z-axis (Sqaure and rectangular section).

( ). Check width-thickness ratio of flange of box (BTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.40*SQRT[Es/Fy] = 33.72
-. Dflg = H-tf1-tf2 = 0.32 m.
-. DTRf = Dflg/tw = 8.50 < Lambda_r ---> NON-SLENDER SECTION !

( ). Check width-thickness ratio of web of box (DTR).
[AASHTO-LRFD12 Specification 6.9.4.2]
-. Lambda_r = 1.49*SQRT[Es/Fy] = 35.88

```
          -. Dweb  =  Cw - tw   =    0.49 m.
          -. DTRw  =  Dweb/tf   =   12.91  <  Lambda_r  --->  NON-SLENDER SECTION !

      ( ). Calculate reduction factor of stiffened elements (Qa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. A_eff  =  Area - 2(Dflg-Bef)*tf - 2(Dweb-Bew)*tw  =      0.068 m^2.
           -. Qa2 =  A_eff/Area  =   1.000  (about z-axis).

      ( ). Calculate reduction factor of stiffened elements (Qa).
           -. Qa  =  1.0 (Stiffened elements are not Slender.)

      ( ). Full reduction factor for slender section (QsQa).
           [ AASHTO-LRFD12 Specification 6.9.4.2 ]
           -. Q  =  Qs*Qa  =   1.000

           -. Po  =  Q*Fy*Area  =  23426.7240 kN.

      ( ). Calculate Flexural Buckling Resistance (Pe_FB).
           [ AASHTO-LRFD12 Specification 6.9.4.1]
                      pi^2 * E
           -. Pe_FB = -----------Area  = 3186662.1081 kN.
                      (Kl/r)^2

      ( ). Torsional and flexural-torsional buckling resistance (Pe_FTB)
           [  AASHTO-LRFD12 Specification 6.9.4.1 (6.9.4.1.3-1) ]
           -. Doubly symmetric shape
           -. Gs   =  7.6903e+007 KPa.
           -. Kx   =      1.00 (Conservatively taken value).
           -. L    =      1.007 m.
           -. Pe_FTB   = [Pi^2*E*Cwp/(Kx*L)^2 + Gs*J]*Aera/(Iyy+Izz)  = 2.9142e+038 kN.

      ( ).  Elastic Critical Buckling Resistance (Pe).
           -. Pe = min[Pe_FB, Pe_FTB ]  = 3186662.1081 kN.

      ( ). Calculate axial compressive strength (phiPn).
           [ AASHTO-LRFD12 Specification 6.9.4.1.1 ]
           -. phi   =          0.90
           -. Pe/Po =        136.03 >= 0.44
           -. Pn    = [0.658^(Po/Pe)]*Po =       23354.75 kN.
           -. phiPn =  phi*Pn  =      21019.28 kN.

      ( ). Check ratio of axial strength (Pu/phiPn).
                Pu              1678.38
           -. -------  =  ---------------  =          0.08  <  1.000  --->  O.K.
              phiPn            21019.28

================================================================================
   [[[*]]]   CHECK FLEXURAL STRENGTH ABOUT MAJOR AXIS.
================================================================================
```

( ). Compute nominal flexural strength(Mny).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mny = Fy*Syy*[1 - (0.064Fy*Syy*Lb)/(A*E)*(SUM(b/t)/Izz)^0.5] = 2821.74 kN-m.

( ). Compute flexural strength about major axis (phiMny).
[AASHTO-LRFD12 Specification 6.12.1.2.1-1]
-. Resistance factor for flexure : phi = 1.00
-. phiMny = phi*Mny = 2821.74 kN-m.

( ). Check ratio of flexural strength (Muy/phiMny).

$$-.\ \frac{Muy}{phiMny} = \frac{491.89}{2821.74} = 0.174 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK FLEXURAL STRENGTH ABOUT MINOR AXIS.

( ). Compute nominal flexural strength(Mnz).
[AASHTO-LRFD12 Specification 6.12.2.2.2-1]
-. Mnz = Fy*Szz*[1 - (0.064Fy*Szz*Lb)/(A*E)*(SUM(b/t)/Iyy)^0.5] = 3515.23 kN-m.

( ). Compute flexural strength about minor axis (phiMnz).
-. Mnz = 3515.23 kN-m.
-. Resistance factor for flexure : phi = 1.00
-. phiMnz = phi*Mnz = 3515.23 kN-m.

( ). Check ratio of flexural strength (Muz/phiMnz).

$$-.\ \frac{Muz}{phiMnz} = \frac{279.25}{3515.23} = 0.079 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK INTERACTION OF COMBINED STRENGTH.

( ). Check interaction ratio of combined strength.
[AASHTO-LRFD12 Specification 6.9.2.2]
-. Pu/phiPn < 0.20 ---> Formula(6.9.2.2-2)

$$-.\ ComRat = \frac{Pu}{2*phiPn} + \left[\frac{Muy}{phiMny} + \frac{Muz}{phiMnz}\right]$$

$$= 0.040 + [\ 0.174 + 0.079\ ]$$

$$= 0.294 < 1.000 \quad ---> \quad O.K.$$

[[[*]]] CHECK SHEAR STRENGTH.

( ). Calculate nominal shear strength in local-y direction (Vny).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asy = 8654.07 kN.
-. Vny = C*Vp = 8654.07 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 152-, POS = J)
-. Applied shear force : Vuy = 188.85 kN.

$$\frac{Vuy}{phiVny} = \frac{188.85}{8654.07} = 0.022 < 1.000 \quad ---> \quad O.K.$$

( ). Calculate nominal shear strength in local-z direction (Vnz).
[AASHTO-LRFD12 Specification 6.10.9.2]
-. Resistance factor for shear : phi = 1.00
-. C = 1.00
-. Vp = 0.58*Fyw*Asz = 6094.42 kN.
-. Vnz = C*Vp = 6094.42 kN.

( ). Check ratio of shear strength (Vu/phiVn).
(LCB = 148+, POS = J)
-. Applied shear force : Vuz = 200.00 kN.

$$\frac{Vuz}{phiVnz} = \frac{200.00}{6094.42} = 0.033 < 1.000 \quad ---> \quad O.K.$$

GOBIERNO DE LA CIUDAD DE MÉXICO **GOBIERNO DE LA CIUDAD DE MÉXICO** SECRETARÍA DE OBRAS Y SERVICIOS Dirección General de Obras Para el Transporte	**CONTRATO No. DGOT-IR-F-4-004-2020** **PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN – AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.** **TRAMO: AV. MOLINO DEL REY 1A. SECCIÓN -AV. COMOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.**	FREDEL INGENIERIA Y ARQUITECTURA S.A. DE C.V.

APÉNDICE 9. DISEÑO DE VIGAS DE ATADO

No. CLAVE: DGOT-20-EST-III-0116-00317-M-00	FECHA: JULIO 2021	HOJA: 1 de 44
TITULO: **APÉNDICE 9. DISEÑO DE VIGAS DE ATADO**	TRAMO: **AV. MOLINO DEL REY 1ª SECCIÓN – AV. DE LOS COMPOSITORES 2ª SECC. DEL BOSQUE DE CHAPULTEPEC**	
ADMINISTRADOR ÚNICO **FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.:** **ING. DAVID SEVERIANO QUINTERO CAMPOS**	**DIRECTOR GENERAL DE OBRAS PARA TRANSPORTE:** **ING. HUGO FLORES SÁNCHEZ**	
APROBÓ: GERENTE DE PROYECTO INTEGRAL **FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.:** **M. EN I. DANIEL PÉREZ BELLO**	**DIRECTOR DE OBRA ELECTROMECÁNICA:** **ING. ALBERTO SÁNCHEZ JUAREZ**	
REVISÓ: SUPERINTENDENTE DE PROYECTO INTEGRAL FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.: **M.V.T. GERMÁN GARCÍA DEHEZA**	**SUBDIRECTOR DE OBRA ELECTROMECÁNICA "A1":** **ING. FELIPE DE JESÚS HERRERA BATRES**	
ELABORÓ: ESPECIALISTA EN ESTRUCTURAS FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.:	**JUD DE SUPERVISIÓN Y CONTROL DE OBRA ELECTROMECÁNICA "A2", RESIDENTE DE OBRA:** **ARQ. MARCELA ERNESTINA YÁÑEZ VÉRTIZ**	

FICHA DE SEGUIMIENTO DE LAS REVISIONES

No.	Descripción de la Modificación	Fecha

DIRECCIÓN GENERAL DE OBRAS PARA EL TRANSPORTE

CONTRATO NO: DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN – AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TRAMO:

AV. MOLINO DEL REY 1A. SECCIÓN -AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

Í N D I C E

APÉNDICE

9. DISEÑO DE VIGAS DE ATADO 4

9.1. CALZADA PEATONAL TRAMO 1 4

9.2. CALZADA PEATONAL TRAMO 2 25

APÉNDICE:

9. DISEÑO DE VIGAS DE ATADO

A continuación, se incluyen los listados de comprobación de las vigas deatado de concreto, para los modelos de cálculo del tramo 1 y tramo 2 de la calzada peatonal.

9.1. CALZADA PEATONAL TRAMO 1

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


       +============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
       |  MIDAS/Civil - Design & checking system for windows        |
       +============================================================+
       |  RC-Member(Beam or Column) Analysis and Design             |
       |  Based On  AASHTO-LRFD16, AASHTO-LRFD12, AASHTO-LRFD07,    |
       |            AASHTO-LRFD02, AASHTO-LFD96, ACI318-02,         |
       |            CSA-S6-00, CSA-S6-14, Eurocode2-2:05,           |
       |            SNiP 2.05.03-84*, SP 35.13330.2011,             |
       |            SNiP 2.05.03-84*(MKS), SP 35.13330.2011(MKS),   |
       |            IRC:21-2000, IRC:112-2011                       |
       |                                                            |
       |                                          (c)SINCE 1989     |
       +============================================================+
       |  MIDAS Information Technology Co.,Ltd.          (MIDAS IT)  |
       |  MIDAS IT Design Development Team                          |
       +============================================================+
       |            HomePage : www.MidasUser.com                    |
       +============================================================+
       |  MIDAS/Civil  Version 8.8.5                                |
       +============================================================+


    *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
------------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
------------------------------------------------------------------------------------------
       3  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
      10  2   Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000)
      13  2        PL01d_ext( 4.300) +     PL01i_ext( 4.300) +     PL01d_int( 4.300)
             +     PL01i_int( 4.300) +     PL02d_ext( 4.300) +     PL02i_ext( 4.300)
             +     PL02d_int( 4.300) +     PL02i_ext( 4.300) +     PL03d_ext( 4.300)
             +     PL03i_ext( 4.300) +     PL03d_int( 4.300) +     PL03i_int( 4.300)
             +     PL04d_ext( 4.300) +     PL04i_ext( 4.300) +     PL04d_int( 4.300)
             +     PL04i_int( 4.300) +     PL05d_ext( 4.300) +     PL05i_ext( 4.300)
             +     PL05d_int( 4.300) +     PL05i_int( 4.300) +     PL06d_ext( 4.300)
             +     PL06i_ext( 4.300) +     PL06d_int( 4.300) +     PL06i_int( 4.300)
             +     PL07d_ext( 4.300) +     PL07i_ext( 4.300) +     PL07d_int( 4.300)
             +     PL07i_int( 4.300) +     PL08d_ext( 4.300) +     PL08i_ext( 4.300)
             +     PL08d_int( 4.300) +     PL08i_int( 4.300) +     PL09d_ext( 4.300)
             +     PL09i_ext( 4.300) +     PL09d_int( 4.300) +     PL09i_int( 4.300)
             +     PL10d_ext( 4.300) +     PL10i_ext( 4.300) +     PL10d_int( 4.300)
             +     PL10i_int( 4.300)
     18+  2       PL01d-ext_( 1.000) +    PL01i-ext_( 1.000) +    PL01d-int_( 1.000)
             +    PL01i-int_( 1.000)
     18-  2       PL01d-ext_( 1.000) +    PL01i-ext_( 1.000) +    PL01d-int_( 1.000)
             +    PL01i-int_( 1.000)
     65+  1       PL01d-ext_( 4.300) +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300)
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+    PL01i-int_( 4.300) +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300)
+    PL02d-int_( 4.300) +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300)
+    PL03i-ext_( 4.300) +    PL03d-int_( 4.300) +    PL03i-int_( 4.300)
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            +    PL10i-int_( 4.300)
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            +    PL07i-int_( 4.300) +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300)
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            +    PL07i-int_( 7.190) +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190)
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            +    PL10i-int_( 7.190)
    66-  1       PL01d-ext_( 7.190) +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190)
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            +    PL10i-int_( 7.190)
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          +           SE02b_( 1.000) +        SE03a_( 1.000) +        SE03b_( 1.000)
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          +           SE11b_( 1.000)
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          +           SE11b_( 1.000)
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          +     PL01i-ext_( 7.525) +     PL01d-int_( 7.525) +     PL01i-int_( 7.525)
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          +         SE01b_( 1.000) +         SE02a_( 1.000) +         SE02b_( 1.000)
          +         SE03a_( 1.000) +         SE03b_( 1.000) +         SE04a_( 1.000)
          +         SE04b_( 1.000) +         SE05a_( 1.000) +         SE05b_( 1.000)
          +         SE06a_( 1.000) +         SE06b_( 1.000) +         SE07a_( 1.000)
          +         SE07b_( 1.000) +         SE08a_( 1.000) +         SE08b_( 1.000)
          +         SE09a_( 1.000) +         SE09b_( 1.000) +         SE10a_( 1.000)
          +         SE10b_( 1.000) +         SE11a_( 1.000) +         SE11b_( 1.000)
    148-  1      DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +     PL01d-ext_( 7.525)
          +     PL01i-ext_( 7.525) +     PL01d-int_( 7.525) +     PL01i-int_( 7.525)
          +     PL02d-ext_( 7.525) +     PL02i-ext_( 7.525) +     PL02d-int_( 7.525)
          +     PL02i-int_( 7.525) +     PL03d-ext_( 7.525) +     PL03i-ext_( 7.525)
          +     PL03d-int_( 7.525) +     PL03i-int_( 7.525) +     PL04d-ext_( 7.525)
          +     PL04i-ext_( 7.525) +     PL04d-int_( 7.525) +     PL04i-int_( 7.525)
          +     PL05d-ext_( 7.525) +     PL05i-ext_( 7.525) +     PL05d-int_( 7.525)
          +     PL05i-int_( 7.525) +     PL06d-ext_( 7.525) +     PL06i-ext_( 7.525)
          +     PL06d-int_( 7.525) +     PL06i-int_( 7.525) +     PL07d-ext_( 7.525)
          +     PL07i-ext_( 7.525) +     PL07d-int_( 7.525) +     PL07i-int_( 7.525)
          +     PL08d-ext_( 7.525) +     PL08i-ext_( 7.525) +     PL08d-int_( 7.525)
          +     PL08i-int_( 7.525) +     PL09d-ext_( 7.525) +     PL09i-ext_( 7.525)
          +     PL09d-int_( 7.525) +     PL09i-int_( 7.525) +     PL10d-ext_( 7.525)
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            +    PL10i-ext_( 7.525) +    PL10d-int_( 7.525) +    PL10i-int_( 7.525)
            +        TU_ENV( 1.200) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   149+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 1.400) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   149-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 1.400) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   151+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_1.0X/0.3Y_ENV( 1.000)
   151-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-ext_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
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            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_1.0X/0.3Y_ENV( 1.000)
    152+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_0.3X/1.0Y_ENV( 1.000)
    152-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_0.3X/1.0Y_ENV( 1.000)
    153+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
    153-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
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            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
   155+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        WS_ENV( 0.300) +        TG_ENV( 0.500)
            +        SE01a_( 1.000) +        SE01b_( 1.000) +        SE02a_( 1.000)
            +        SE02b_( 1.000) +        SE03a_( 1.000) +        SE03b_( 1.000)
            +        SE04a_( 1.000) +        SE04b_( 1.000) +        SE05a_( 1.000)
            +        SE05b_( 1.000) +        SE06a_( 1.000) +        SE06b_( 1.000)
            +        SE07a_( 1.000) +        SE07b_( 1.000) +        SE08a_( 1.000)
            +        SE08b_( 1.000) +        SE09a_( 1.000) +        SE09b_( 1.000)
            +        SE10a_( 1.000) +        SE10b_( 1.000) +        SE11a_( 1.000)
            +        SE11b_( 1.000)
   155-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        WS_ENV( 0.300) +        TG_ENV( 0.500)
            +        SE01a_( 1.000) +        SE01b_( 1.000) +        SE02a_( 1.000)
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            +        SE02b_( 1.000) +        SE03a_( 1.000) +        SE03b_( 1.000)
            +        SE04a_( 1.000) +        SE04b_( 1.000) +        SE05a_( 1.000)
            +        SE05b_( 1.000) +        SE06a_( 1.000) +        SE06b_( 1.000)
            +        SE07a_( 1.000) +        SE07b_( 1.000) +        SE08a_( 1.000)
            +        SE08b_( 1.000) +        SE09a_( 1.000) +        SE09b_( 1.000)
            +        SE10a_( 1.000) +        SE10b_( 1.000) +        SE11a_( 1.000)
            +        SE11b_( 1.000)
    156+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 5.590)
            +    PL01i-ext_( 5.590) +    PL01d-int_( 5.590) +    PL01i-int_( 5.590)
            +    PL02d-ext_( 5.590) +    PL02i-ext_( 5.590) +    PL02d-int_( 5.590)
            +    PL02i-int_( 5.590) +    PL03d-ext_( 5.590) +    PL03i-ext_( 5.590)
            +    PL03d-int_( 5.590) +    PL03i-int_( 5.590) +    PL04d-ext_( 5.590)
            +    PL04i-ext_( 5.590) +    PL04d-int_( 5.590) +    PL04i-int_( 5.590)
            +    PL05d-ext_( 5.590) +    PL05i-ext_( 5.590) +    PL05d-int_( 5.590)
            +    PL05i-int_( 5.590) +    PL06d-ext_( 5.590) +    PL06i-ext_( 5.590)
            +    PL06d-int_( 5.590) +    PL06i-int_( 5.590) +    PL07d-ext_( 5.590)
            +    PL07i-ext_( 5.590) +    PL07d-int_( 5.590) +    PL07i-int_( 5.590)
            +    PL08d-ext_( 5.590) +    PL08i-ext_( 5.590) +    PL08d-int_( 5.590)
            +    PL08i-int_( 5.590) +    PL09d-ext_( 5.590) +    PL09i-ext_( 5.590)
            +    PL09d-int_( 5.590) +    PL09i-int_( 5.590) +    PL10d-ext_( 5.590)
            +    PL10i-ext_( 5.590) +    PL10d-int_( 5.590) +    PL10i-int_( 5.590)
            +        TU_ENV( 1.200)
    156-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 5.590)
            +    PL01i-ext_( 5.590) +    PL01d-int_( 5.590) +    PL01i-int_( 5.590)
            +    PL02d-ext_( 5.590) +    PL02i-ext_( 5.590) +    PL02d-int_( 5.590)
            +    PL02i-int_( 5.590) +    PL03d-ext_( 5.590) +    PL03i-ext_( 5.590)
            +    PL03d-int_( 5.590) +    PL03i-int_( 5.590) +    PL04d-ext_( 5.590)
            +    PL04i-ext_( 5.590) +    PL04d-int_( 5.590) +    PL04i-int_( 5.590)
            +    PL05d-ext_( 5.590) +    PL05i-ext_( 5.590) +    PL05d-int_( 5.590)
            +    PL05i-int_( 5.590) +    PL06d-ext_( 5.590) +    PL06i-ext_( 5.590)
            +    PL06d-int_( 5.590) +    PL06i-int_( 5.590) +    PL07d-ext_( 5.590)
            +    PL07i-ext_( 5.590) +    PL07d-int_( 5.590) +    PL07i-int_( 5.590)
            +    PL08d-ext_( 5.590) +    PL08i-ext_( 5.590) +    PL08d-int_( 5.590)
            +    PL08i-int_( 5.590) +    PL09d-ext_( 5.590) +    PL09i-ext_( 5.590)
            +    PL09d-int_( 5.590) +    PL09i-int_( 5.590) +    PL10d-ext_( 5.590)
            +    PL10i-ext_( 5.590) +    PL10d-int_( 5.590) +    PL10i-int_( 5.590)
            +        TU_ENV( 1.200)
    157+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
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            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   157-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   158+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 0.700) +        SE01a_( 1.000) +        SE01b_( 1.000)
            +        SE02a_( 1.000) +        SE02b_( 1.000) +        SE03a_( 1.000)
            +        SE03b_( 1.000) +        SE04a_( 1.000) +        SE04b_( 1.000)
            +        SE05a_( 1.000) +        SE05b_( 1.000) +        SE06a_( 1.000)
            +        SE06b_( 1.000) +        SE07a_( 1.000) +        SE07b_( 1.000)
            +        SE08a_( 1.000) +        SE08b_( 1.000) +        SE09a_( 1.000)
            +        SE09b_( 1.000) +        SE10a_( 1.000) +        SE10b_( 1.000)
            +        SE11a_( 1.000) +        SE11b_( 1.000)
   158-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 0.700) +        SE01a_( 1.000) +        SE01b_( 1.000)
            +        SE02a_( 1.000) +        SE02b_( 1.000) +        SE03a_( 1.000)
            +        SE03b_( 1.000) +        SE04a_( 1.000) +        SE04b_( 1.000)
            +        SE05a_( 1.000) +        SE05b_( 1.000) +        SE06a_( 1.000)
            +        SE06b_( 1.000) +        SE07a_( 1.000) +        SE07b_( 1.000)
            +        SE08a_( 1.000) +        SE08b_( 1.000) +        SE09a_( 1.000)
            +        SE09b_( 1.000) +        SE10a_( 1.000) +        SE10b_( 1.000)
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          +        SE11a_( 1.000) +        SE11b_( 1.000)
   159+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
          +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
          +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
          +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
          +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
          +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
          +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
          +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
          +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
          +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
          +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
          +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
          +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
          +EQ_Ser_1.0X/0.3Y( 1.000)
   159-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
          +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
          +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
          +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
          +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
          +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
          +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
          +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
          +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
          +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
          +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
          +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
          +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
          +EQ_Ser_1.0X/0.3Y( 1.000)
   160+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
          +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
          +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
          +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
          +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
          +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
          +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
          +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
          +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
          +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
          +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
          +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
          +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
          +EQ_Ser_0.3X/1.0Y( 1.000)
   160-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
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            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_Ser_0.3X/1.0Y( 1.000)
     162  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000)
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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================

      *.MIDAS/Civil - RC-BEAM Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = BEAM,   MEMB =112000

      *.DESCRIPTION OF BEAM DATA (iSEC =    65) : Viga_120x100
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         8.500 m.
        Section Depth (Hc)             =         1.000 m.
        Section Width (Bc)             =         1.200 m.
        Concrete Strength (fc')        =     27579.038 KPa.
        Main Rebar Strength (fy)       =    413685.566 KPa.
        Stirrups Strength (fys)        =    413685.566 KPa.
        Modulus of Elasticity (Es)     = 199948023.746 KPa.

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =     5072.86 kN-m.,  LCB =152+
        Negative Bending Moment   N-Mu =     5317.52 kN-m.,  LCB =152-
        Shear Force               Vu   =     1358.63 kN.  ,  LCB =152-

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ------------------------------------------------------
           Top         1      0.085       11-#10      0.00901
           Top         2      0.115       11-#10      0.00901
           Top         3      0.200        2- #8      0.00102
           Top         4      0.300        2- #8      0.00102
           Top         5      0.400        2- #8      0.00102
           Bottom      1      0.085       11-#10      0.00901
           Bottom      2      0.115       11-#10      0.00901
           Bottom      3      0.200        2- #8      0.00102
           Bottom      4      0.300        2- #8      0.00102
           Bottom      5      0.400        2- #8      0.00102
        ------------------------------------------------------
           Stirrups : 6.0-#5  @150

 ============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ============================================================================

      ( ). Compute parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. d     =     0.8710 m.
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomin1 = (1.2)*Mcr/[ phi*fy*b*d*(d-a/2) ]      =   0.0024
           -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ]        =   0.0276
           -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]               =   0.0024
           -. As_min =  Rhomin * Ag  =     0.0029 m^2.
```

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.968 ---> O.K !

[[[*]]] ANALYZE POSITIVE BENDING MOMENT CAPACITY.

( ). Compute parameter.
-. phi = 0.90
-. Alpha = 0.85
-. Beta = 0.85
-. d = 0.8710 m.
-. ecu = 0.0030

( ). Compute maximum and minimum reinforcement.
-. Rhomin1 = (1.2)*Mcr/[phi*fy*b*d*(d-a/2)] = 0.0024
-. Rhomin2 = 1.33*Mu/[phi*fy*b*d*(d-a/2)] = 0.0258
-. Rhomin = MIN[Rhomin1, Rhomin2] = 0.0024
-. As_min = Rhomin * Ag = 0.0029 m^2.

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.923 ---> O.K !

[[[*]]] ANALYZE SHEAR CAPACITY.

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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2020
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      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0012 m^2.
           -. bv    =   1.20 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.78 m.
           -. theta =  36.14 Deg.   [Clause 5.8.3.4.2]
           -. beta  =   1.90

      ( ). Compute shear strength of concrete.
           -. Vu     =     1358.63 kN.
           -. Vc     = 0.0316*beta*SQRT[fc']*bv*dv =      777.44 kN.
           -. phiVc  = phi * Vc =      699.70 kN.
           -. Vn_lim = 0.25*fc'*bv*dv =     6485.70 kN.

      ( ). Compute stirrup spacing.
           -. Maximum spacing smax = MIN[ 0.8*dv, 24 in ] =    0.610 m.
           -. Vu > phiVc  --->  Required shear reinforcement.
           -.                   smax = MIN[ smax, Av/(0.0316*SQRT(fc')*bv/fys) ] =    0.610 m.
           -. Applied spacing s    =    0.150 m.

      ( ). Compute shear strength of reinforcement.
           -. Vs      = Av*fys*dv*cot(theta) / s =     3551.98 kN.
           -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     5708.26 kN.
           -. Vs      = MIN[ Vs, Vs_lim ] =     3551.98 kN.
           -. phiVs   = phi*Vs =     3196.78 kN.

           -. phiVs > (Vu-phiVc)  --->  O.K !
           -. Using Av/s  =  Vs / (fys*dv*cot(theta)) =   0.0080 m^2/m.

      ( ). Check tension force in the longitudinal reinforcement caused by shear.
           -. phib    =   0.90
           -. phiv    =   0.90
           -. Vs1     =  MIN[ Vs, Vu/phiv ] =     1509.59 kN.
           -. As_req  =  [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta) ] / fy =   0.0207 m^2.
           -. As      =   0.0211 m^2.
           -. As_req < As  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE TORSION CAPACITY.
 ============================================================================

      ( ). Compute torsion parameter.
           -. phi   =   0.90
           -. Acp   =       1.20 m^2.
           -. Pc    =       4.40 m.
           -. Aoh   =       1.00 m^2.
           -. Ao    =  0.85*Aoh =      0.85 m^2.
           -. Ph    =       4.04 m.
           -. Tu    =       -347.64 kN-m.
           -. theta =  36.14 Deg.
           -. Tcr   =  0.125*SQRT(fc')*Acp^2/Pc =       564.12 kN-m.

           -. Tu > 0.25*phi*Tcr =       126.93 kN-m.
               ---> Required torsion checking.
```

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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                          Civil 2020
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      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0012 m^2.
           -. bv    =   1.20 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.78 m.
           -. theta =  36.14 Deg.   [Clause 5.8.3.4.2]
           -. beta  =   1.90
           -. smax  =   0.61
           -. Vs    =       3551.98

      ( ). Compute torsional resistance.
           -. Tu       =    -347.64 kN-m.
           -. At       =     0.0002 m^2.
           -. St       =       0.15 m.
           -. phiTn    =  phi*2*Ao*At*fy*cot(theta)/St =   1160.87 kN-m.

           -. Tu/phiTn =  0.30  --->  O.K !

      ( ). Check longitudinal reinforcement.
           -. phi_f =  0.90
           -. phi_v =  0.90
           -. Mu    =   5317.52 kN-m.
           -. Vu    =   1358.63 kN.
           -. Vs    =   3551.98 kN.
           -. As*fy =   8722.08 kN.
           -. Asfy_min_param1 = (ABS(Vu/phi_v)-0.5*Vs)^2
           -. Asfy_min_param2 = (0.45*Ph*Tu/(2*Ao*phi_v))^2
           -. Asfy_min = ABS(Mu)/(phi_f*dv) +
                         cot(theta)*SQRT( Asfy_min_param1 + Asfy_min_param2 ) =   8021.32 kN.

           -. As*fy >= Asfy_min   --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB = 160- )
           -. Mu      =   1795.6927 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0850 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.13 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.3245 m.
           -. Icr     =      0.0714 m^4.
           -. fss     =    118325.150 KPa.
           -. s       =       0.0966 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.7447 m.
           -. s < sa --->  O.K !
```

( ). Check crack control of bottom reinforcement. (LCB = 160+)
-. Mu = 1569.0936 kN-m.
-. h = 1.0000 m.
-. dc = 0.0850 m.
-. Beta_s = 1+dc/(0.7*(h-dc)) = 1.13 m.
-. Gamma_e = 1.00
-. c_cr = 0.3245 m.
-. Icr = 0.0714 m^4.
-. fss = 103393.657 KPa.
-. s = 0.0966 m.
-. sa = 700*Gamma_e/(Beta_s*fss)-2*dc = 0.8767 m.
-. s < sa ---> O.K !

MIDAS/Civil - RC-Beam Checking [AASHTO-LRFD12] Civil 2020

*.MIDAS/Civil - RC-BEAM Analysis/Design Program.

*.PROJECT :
*.DESIGN CODE : AASHTO-LRFD12, *.UNIT SYSTEM : kN, m
*.MEMBER : Member Type = BEAM, MEMB =116000

*.DESCRIPTION OF BEAM DATA (iSEC = 65) : Viga_120x100
Section Type : Rectangle (RECT)
Beam Length (Span) = 8.499 m.
Section Depth (Hc) = 1.000 m.
Section Width (Bc) = 1.200 m.
Concrete Strength (fc') = 27579.038 KPa.
Main Rebar Strength (fy) = 413685.566 KPa.
Stirrups Strength (fys) = 413685.566 KPa.
Modulus of Elasticity (Es) = 199948023.746 KPa.

*.FORCES AND MOMENTS AT CHECK POINT <I> :
Positive Bending Moment P-Mu = 4455.57 kN-m., LCB =152+
Negative Bending Moment N-Mu = 4732.72 kN-m., LCB =152-
Shear Force Vu = 1222.90 kN. , LCB =152-

*.REINFORCEMENT PATTERN :

Location	i	di(m.)	Rebar	Asi(m^2.)
Top	1	0.085	11-#10	0.00901
Top	2	0.115	11-#10	0.00901
Top	3	0.200	2- #8	0.00102
Top	4	0.300	2- #8	0.00102
Top	5	0.400	2- #8	0.00102
Bottom	1	0.085	11-#10	0.00901
Bottom	2	0.115	11-#10	0.00901
Bottom	3	0.200	2- #8	0.00102
Bottom	4	0.300	2- #8	0.00102
Bottom	5	0.400	2- #8	0.00102

Stirrups : 6.0-#5 @150

[[[*]]] ANALYZE NEGATIVE BENDING MOMENT CAPACITY.

( ). Compute parameter.
-. phi = 0.90
-. Alpha = 0.85
-. Beta = 0.85
-. d = 0.8710 m.

-. ecu = 0.0030

( ). Compute maximum and minimum reinforcement.
-. Rhomin1 = (1.2)*Mcr/[phi*fy*b*d*(d-a/2)] = 0.0024
-. Rhomin2 = 1.33*Mu/[phi*fy*b*d*(d-a/2)] = 0.0234
-. Rhomin = MIN[Rhomin1, Rhomin2] = 0.0024
-. As_min = Rhomin * Ag = 0.0029 m^2.

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.861 ---> O.K !

[[[*]]] ANALYZE POSITIVE BENDING MOMENT CAPACITY.

( ). Compute parameter.
-. phi = 0.90
-. Alpha = 0.85
-. Beta = 0.85
-. d = 0.8710 m.
-. ecu = 0.0030

( ). Compute maximum and minimum reinforcement.
-. Rhomin1 = (1.2)*Mcr/[phi*fy*b*d*(d-a/2)] = 0.0024
-. Rhomin2 = 1.33*Mu/[phi*fy*b*d*(d-a/2)] = 0.0216
-. Rhomin = MIN[Rhomin1, Rhomin2] = 0.0024
-. As_min = Rhomin * Ag = 0.0029 m^2.

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.811 ---> O.K !

[[[*]]] ANALYZE SHEAR CAPACITY.

( ). Compute shear parameter.
-. phi = 0.90
-. Av = 0.0012 m^2.
-. bv = 1.20 m.
-. dv = MAX[dv, 0.9*d, 0.72*Hc] = 0.78 m.
-. theta = 35.38 Deg. [Clause 5.8.3.4.2]
-. beta = 2.03

( ). Compute shear strength of concrete.
-. Vu = 1222.90 kN.
-. Vc = 0.0316*beta*SQRT[fc']*bv*dv = 831.42 kN.
-. phiVc = phi * Vc = 748.28 kN.
-. Vn_lim = 0.25*fc'*bv*dv = 6485.70 kN.

( ). Compute stirrup spacing.
-. Maximum spacing smax = MIN[0.8*dv, 24 in] = 0.610 m.
-. Vu > phiVc ---> Required shear reinforcement.
-. smax = MIN[smax, Av/(0.0316*SQRT(fc')*bv/fys)] = 0.610 m.
-. Applied spacing s = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vs = Av*fys*dv*cot(theta) / s = 3653.65 kN.
-. Vs_lim = 0.25*fc'*bv*dv - Vc = 5654.28 kN.
-. Vs = MIN[Vs, Vs_lim] = 3653.65 kN.
-. phiVs = phi*Vs = 3288.28 kN.

-. phiVs > (Vu-phiVc) ---> O.K !
-. Using Av/s = Vs / (fys*dv*cot(theta)) = 0.0080 m^2/m.

( ). Check tension force in the longitudinal reinforcement caused by shear.
-. phib = 0.90
-. phiv = 0.90
-. Vs1 = MIN[Vs, Vu/phiv] = 1358.78 kN.
-. As_req = [Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta)] / fy = 0.0185 m^2.
-. As = 0.0211 m^2.
-. As_req < As ---> O.K !

==========

[[[*]]] ANALYZE TORSION CAPACITY.

==========

( ). Compute torsion parameter.
-. phi = 0.90
-. Acp = 1.20 m^2.
-. Pc = 4.40 m.
-. Aoh = 1.00 m^2.
-. Ao = 0.85*Aoh = 0.85 m^2.
-. Ph = 4.04 m.
-. Tu = -285.83 kN-m.
-. theta = 35.38 Deg.
-. Tcr = 0.125*SQRT(fc')*Acp^2/Pc = 564.12 kN-m.

-. Tu > 0.25*phi*Tcr = 126.93 kN-m.
---> Required torsion checking.

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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0012 m^2.
           -. bv    =   1.20 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.78 m.
           -. theta =  35.38 Deg.   [Clause 5.8.3.4.2]
           -. beta  =   2.03
           -. smax  =   0.61
           -. Vs    =       3653.65

      ( ). Compute torsional resistance.
           -. Tu       =    -285.83 kN-m.
           -. At       =     0.0002 m^2.
           -. St       =       0.15 m.
           -. phiTn    =  phi*2*Ao*At*fy*cot(theta)/St =   1194.10 kN-m.

           -. Tu/phiTn =  0.24  --->  O.K !

      ( ). Check longitudinal reinforcement.
           -. phi_f =  0.90
           -. phi_v =  0.90
           -. Mu    =   4732.72 kN-m.
           -. Vu    =   1222.90 kN.
           -. Vs    =   3653.65 kN.
           -. As*fy =   8722.08 kN.
           -. Asfy_min_param1 = (ABS(Vu/phi_v)-0.5*Vs)^2
           -. Asfy_min_param2 = (0.45*Ph*Tu/(2*Ao*phi_v))^2
           -. Asfy_min = ABS(Mu)/(phi_f*dv) +
                         cot(theta)*SQRT( Asfy_min_param1 + Asfy_min_param2 ) =   7365.45 kN.

           -. As*fy >= Asfy_min   --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB = 160- )
           -. Mu      =   1633.5358 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0850 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.13 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.3245 m.
           -. Icr     =      0.0714 m^4.
           -. fss     =    107640.003 KPa.
           -. s       =       0.0966 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.8354 m.
           -. s < sa --->  O.K !
```

( ). Check crack control of bottom reinforcement. (LCB = 160+)
-. Mu = 1376.4050 kN-m.
-. h = 1.0000 m.
-. dc = 0.0850 m.
-. Beta_s = 1+dc/(0.7*(h-dc)) = 1.13 m.
-. Gamma_e = 1.00
-. c_cr = 0.3245 m.
-. Icr = 0.0714 m^4.
-. fss = 90696.659 KPa.
-. s = 0.0966 m.
-. sa = 700*Gamma_e/(Beta_s*fss)-2*dc = 1.0233 m.
-. s < sa ---> O.K !

9.2. CALZADA PEATONAL TRAMO 2

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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2020
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       +============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
       |  MIDAS/Civil - Design & checking system for windows        |
       +============================================================+
       |  RC-Member(Beam or Column) Analysis and Design             |
       |  Based On  AASHTO-LRFD16, AASHTO-LRFD12, AASHTO-LRFD07,    |
       |            AASHTO-LRFD02, AASHTO-LFD96, ACI318-02,         |
       |            CSA-S6-00, CSA-S6-14, Eurocode2-2:05,           |
       |            SNiP 2.05.03-84*, SP 35.13330.2011,             |
       |            SNiP 2.05.03-84*(MKS), SP 35.13330.2011(MKS),   |
       |            IRC:21-2000, IRC:112-2011                       |
       |                                                            |
       |                                          (c)SINCE 1989  |
       +============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)  |
       |  MIDAS IT Design Development Team                          |
       +============================================================+
       |            HomePage : www.MidasUser.com                    |
       +============================================================+
       |  MIDAS/Civil  Version 8.8.5                                |
       +============================================================+


    *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
------------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
------------------------------------------------------------------------------------------
       3  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
      10  2   Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000)
      13  2        PL01d_ext( 4.300) +     PL01i_ext( 4.300) +     PL01d_int( 4.300)
             +     PL01i_int( 4.300) +     PL02d_ext( 4.300) +     PL02i_ext( 4.300)
             +     PL02d_int( 4.300) +     PL02i_int( 4.300) +     PL03d_ext( 4.300)
             +     PL03i_ext( 4.300) +     PL03d_int( 4.300) +     PL03i_int( 4.300)
             +     PL04d_ext( 4.300) +     PL04i_ext( 4.300) +     PL04d_int( 4.300)
             +     PL04i_int( 4.300) +     PL05d_ext( 4.300) +     PL05i_ext( 4.300)
             +     PL05d_int( 4.300) +     PL05i_int( 4.300) +     PL06d_ext( 4.300)
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             +     PL07i_int( 4.300) +     PL08d_ext( 4.300) +     PL08i_ext( 4.300)
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             +     PL10i_int( 4.300)
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             +    PL01i-int_( 1.000)
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             +    PL01i-int_( 1.000)
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              +    PL10i-int_( 7.190)
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          +           SE08b_( 1.000) +        SE09a_( 1.000) +        SE09b_( 1.000)
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          +           SE11b_( 1.000)
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          +           SE11b_( 1.000)
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            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
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            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   151+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_1.0X/0.3Y_ENV( 1.000)
   151-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
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            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_1.0X/0.3Y_ENV( 1.000)
    152+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_0.3X/1.0Y_ENV( 1.000)
    152-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_0.3X/1.0Y_ENV( 1.000)
    153+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
    153-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
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            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
    155+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        WS_ENV( 0.300) +        TG_ENV( 0.500)
            +        SE01a_( 1.000) +        SE01b_( 1.000) +        SE02a_( 1.000)
            +        SE02b_( 1.000) +        SE03a_( 1.000) +        SE03b_( 1.000)
            +        SE04a_( 1.000) +        SE04b_( 1.000) +        SE05a_( 1.000)
            +        SE05b_( 1.000) +        SE06a_( 1.000) +        SE06b_( 1.000)
            +        SE07a_( 1.000) +        SE07b_( 1.000) +        SE08a_( 1.000)
            +        SE08b_( 1.000) +        SE09a_( 1.000) +        SE09b_( 1.000)
            +        SE10a_( 1.000) +        SE10b_( 1.000) +        SE11a_( 1.000)
            +        SE11b_( 1.000)
    155-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        WS_ENV( 0.300) +        TG_ENV( 0.500)
            +        SE01a_( 1.000) +        SE01b_( 1.000) +        SE02a_( 1.000)
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            +        SE02b_( 1.000) +        SE03a_( 1.000) +        SE03b_( 1.000)
            +        SE04a_( 1.000) +        SE04b_( 1.000) +        SE05a_( 1.000)
            +        SE05b_( 1.000) +        SE06a_( 1.000) +        SE06b_( 1.000)
            +        SE07a_( 1.000) +        SE07b_( 1.000) +        SE08a_( 1.000)
            +        SE08b_( 1.000) +        SE09a_( 1.000) +        SE09b_( 1.000)
            +        SE10a_( 1.000) +        SE10b_( 1.000) +        SE11a_( 1.000)
            +        SE11b_( 1.000)
    156+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 5.590)
            +    PL01i-ext_( 5.590) +    PL01d-int_( 5.590) +    PL01i-int_( 5.590)
            +    PL02d-ext_( 5.590) +    PL02i-ext_( 5.590) +    PL02d-int_( 5.590)
            +    PL02i-int_( 5.590) +    PL03d-ext_( 5.590) +    PL03i-ext_( 5.590)
            +    PL03d-int_( 5.590) +    PL03i-int_( 5.590) +    PL04d-ext_( 5.590)
            +    PL04i-ext_( 5.590) +    PL04d-int_( 5.590) +    PL04i-int_( 5.590)
            +    PL05d-ext_( 5.590) +    PL05i-ext_( 5.590) +    PL05d-int_( 5.590)
            +    PL05i-int_( 5.590) +    PL06d-ext_( 5.590) +    PL06i-ext_( 5.590)
            +    PL06d-int_( 5.590) +    PL06i-int_( 5.590) +    PL07d-ext_( 5.590)
            +    PL07i-ext_( 5.590) +    PL07d-int_( 5.590) +    PL07i-int_( 5.590)
            +    PL08d-ext_( 5.590) +    PL08i-ext_( 5.590) +    PL08d-int_( 5.590)
            +    PL08i-int_( 5.590) +    PL09d-ext_( 5.590) +    PL09i-ext_( 5.590)
            +    PL09d-int_( 5.590) +    PL09i-int_( 5.590) +    PL10d-ext_( 5.590)
            +    PL10i-ext_( 5.590) +    PL10d-int_( 5.590) +    PL10i-int_( 5.590)
            +        TU_ENV( 1.200)
    156-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 5.590)
            +    PL01i-ext_( 5.590) +    PL01d-int_( 5.590) +    PL01i-int_( 5.590)
            +    PL02d-ext_( 5.590) +    PL02i-ext_( 5.590) +    PL02d-int_( 5.590)
            +    PL02i-int_( 5.590) +    PL03d-ext_( 5.590) +    PL03i-ext_( 5.590)
            +    PL03d-int_( 5.590) +    PL03i-int_( 5.590) +    PL04d-ext_( 5.590)
            +    PL04i-ext_( 5.590) +    PL04d-int_( 5.590) +    PL04i-int_( 5.590)
            +    PL05d-ext_( 5.590) +    PL05i-ext_( 5.590) +    PL05d-int_( 5.590)
            +    PL05i-int_( 5.590) +    PL06d-ext_( 5.590) +    PL06i-ext_( 5.590)
            +    PL06d-int_( 5.590) +    PL06i-int_( 5.590) +    PL07d-ext_( 5.590)
            +    PL07i-ext_( 5.590) +    PL07d-int_( 5.590) +    PL07i-int_( 5.590)
            +    PL08d-ext_( 5.590) +    PL08i-ext_( 5.590) +    PL08d-int_( 5.590)
            +    PL08i-int_( 5.590) +    PL09d-ext_( 5.590) +    PL09i-ext_( 5.590)
            +    PL09d-int_( 5.590) +    PL09i-int_( 5.590) +    PL10d-ext_( 5.590)
            +    PL10i-ext_( 5.590) +    PL10d-int_( 5.590) +    PL10i-int_( 5.590)
            +        TU_ENV( 1.200)
    157+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
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            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   157-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +        TU_ENV( 1.200) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   158+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 0.700) +        SE01a_( 1.000) +        SE01b_( 1.000)
            +        SE02a_( 1.000) +        SE02b_( 1.000) +        SE03a_( 1.000)
            +        SE03b_( 1.000) +        SE04a_( 1.000) +        SE04b_( 1.000)
            +        SE05a_( 1.000) +        SE05b_( 1.000) +        SE06a_( 1.000)
            +        SE06b_( 1.000) +        SE07a_( 1.000) +        SE07b_( 1.000)
            +        SE08a_( 1.000) +        SE08b_( 1.000) +        SE09a_( 1.000)
            +        SE09b_( 1.000) +        SE10a_( 1.000) +        SE10b_( 1.000)
            +        SE11a_( 1.000) +        SE11b_( 1.000)
   158-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 0.700) +        SE01a_( 1.000) +        SE01b_( 1.000)
            +        SE02a_( 1.000) +        SE02b_( 1.000) +        SE03a_( 1.000)
            +        SE03b_( 1.000) +        SE04a_( 1.000) +        SE04b_( 1.000)
            +        SE05a_( 1.000) +        SE05b_( 1.000) +        SE06a_( 1.000)
            +        SE06b_( 1.000) +        SE07a_( 1.000) +        SE07b_( 1.000)
            +        SE08a_( 1.000) +        SE08b_( 1.000) +        SE09a_( 1.000)
            +        SE09b_( 1.000) +        SE10a_( 1.000) +        SE10b_( 1.000)
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          +        SE11a_( 1.000) +        SE11b_( 1.000)
   159+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
          +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
          +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
          +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
          +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
          +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
          +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
          +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
          +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
          +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
          +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
          +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
          +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
          +EQ_Ser_1.0X/0.3Y( 1.000)
   159-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
          +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
          +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
          +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
          +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
          +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
          +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
          +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
          +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
          +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
          +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
          +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
          +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
          +EQ_Ser_1.0X/0.3Y( 1.000)
   160+  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
          +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
          +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
          +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
          +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
          +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
          +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
          +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
          +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
          +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
          +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
          +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
          +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
          +EQ_Ser_0.3X/1.0Y( 1.000)
   160-  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
          +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000) +    PL01d-ext_( 4.300)
          +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
```

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            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_Ser_0.3X/1.0Y( 1.000)
     162  2      Peso propio( 1.000) +  Peso lastres( 1.000) +Pavimento estructural( 4.000)
            +Pavimento no estructural( 1.650) +Barandilla y luminarias( 1.000)
```

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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-BEAM Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = BEAM,   MEMB =115000

      *.DESCRIPTION OF BEAM DATA (iSEC =    65) : Viga_120x100
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         8.500 m.
        Section Depth (Hc)             =         1.000 m.
        Section Width (Bc)             =         1.200 m.
        Concrete Strength (fc')        =     27579.038 KPa.
        Main Rebar Strength (fy)       =    413685.566 KPa.
        Stirrups Strength (fys)        =    413685.566 KPa.
        Modulus of Elasticity (Es)     = 199948023.746 KPa.

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =     4655.85 kN-m.,  LCB =152+
        Negative Bending Moment   N-Mu =     4943.92 kN-m.,  LCB =152-
        Shear Force               Vu   =     1273.47 kN.  ,  LCB =152-

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ------------------------------------------------------
           Top         1      0.085       11-#10      0.00901
           Top         2      0.115       11-#10      0.00901
           Top         3      0.200        2- #8      0.00102
           Top         4      0.300        2- #8      0.00102
           Top         5      0.400        2- #8      0.00102
           Bottom      1      0.085       11-#10      0.00901
           Bottom      2      0.115       11-#10      0.00901
           Bottom      3      0.200        2- #8      0.00102
           Bottom      4      0.300        2- #8      0.00102
           Bottom      5      0.400        2- #8      0.00102
        ------------------------------------------------------
           Stirrups : 6.0-#5  @150

 ================================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ================================================================================

      ( ). Compute parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. d     =     0.8710 m.
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomin1 = (1.2)*Mcr/[ phi*fy*b*d*(d-a/2) ]      =   0.0024
           -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ]        =   0.0248
           -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]               =   0.0024
           -. As_min =  Rhomin * Ag  =     0.0029 m^2.
```

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.900 ---> O.K !

[[[*]]] ANALYZE POSITIVE BENDING MOMENT CAPACITY.

( ). Compute parameter.
-. phi = 0.90
-. Alpha = 0.85
-. Beta = 0.85
-. d = 0.8710 m.
-. ecu = 0.0030

( ). Compute maximum and minimum reinforcement.
-. Rhomin1 = (1.2)*Mcr/[phi*fy*b*d*(d-a/2)] = 0.0024
-. Rhomin2 = 1.33*Mu/[phi*fy*b*d*(d-a/2)] = 0.0229
-. Rhomin = MIN[Rhomin1, Rhomin2] = 0.0024
-. As_min = Rhomin * Ag = 0.0029 m^2.

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.847 ---> O.K !

[[[*]]] ANALYZE SHEAR CAPACITY.

( ). Compute shear parameter.
-. phi = 0.90
-. Av = 0.0012 m^2.
-. bv = 1.20 m.
-. dv = MAX[dv, 0.9*d, 0.72*Hc] = 0.78 m.
-. theta = 35.69 Deg. [Clause 5.8.3.4.2]
-. beta = 1.97

( ). Compute shear strength of concrete.
-. Vu = 1273.47 kN.
-. Vc = 0.0316*beta*SQRT[fc']*bv*dv = 808.75 kN.
-. phiVc = phi * Vc = 727.88 kN.
-. Vn_lim = 0.25*fc'*bv*dv = 6485.70 kN.

( ). Compute stirrup spacing.
-. Maximum spacing smax = MIN[0.8*dv, 24 in] = 0.610 m.
-. Vu > phiVc ---> Required shear reinforcement.
-. smax = MIN[smax, Av/(0.0316*SQRT(fc')*bv/fys)] = 0.610 m.
-. Applied spacing s = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vs = Av*fys*dv*cot(theta) / s = 3612.15 kN.
-. Vs_lim = 0.25*fc'*bv*dv - Vc = 5676.95 kN.
-. Vs = MIN[Vs, Vs_lim] = 3612.15 kN.
-. phiVs = phi*Vs = 3250.93 kN.

-. phiVs > (Vu-phiVc) ---> O.K !
-. Using Av/s = Vs / (fys*dv*cot(theta)) = 0.0080 m^2/m.

( ). Check tension force in the longitudinal reinforcement caused by shear.
-. phib = 0.90
-. phiv = 0.90
-. Vs1 = MIN[Vs, Vu/phiv] = 1414.96 kN.
-. As_req = [Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta)] / fy = 0.0193 m^2.
-. As = 0.0211 m^2.
-. As_req < As ---> O.K !

==========

[[[*]]] ANALYZE TORSION CAPACITY.

==========

( ). Compute torsion parameter.
-. phi = 0.90
-. Acp = 1.20 m^2.
-. Pc = 4.40 m.
-. Aoh = 1.00 m^2.
-. Ao = 0.85*Aoh = 0.85 m^2.
-. Ph = 4.04 m.
-. Tu = -240.60 kN-m.
-. theta = 35.69 Deg.
-. Tcr = 0.125*SQRT(fc')*Acp^2/Pc = 564.12 kN-m.

-. Tu > 0.25*phi*Tcr = 126.93 kN-m.
---> Required torsion checking.

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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                          Civil 2020
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      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0012 m^2.
           -. bv    =   1.20 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.78 m.
           -. theta =  35.69 Deg.   [Clause 5.8.3.4.2]
           -. beta  =   1.97
           -. smax  =   0.61
           -. Vs    =       3612.15

      ( ). Compute torsional resistance.
           -. Tu       =    -240.60 kN-m.
           -. At       =     0.0002 m^2.
           -. St       =       0.15 m.
           -. phiTn    =  phi*2*Ao*At*fy*cot(theta)/St =   1180.54 kN-m.

           -. Tu/phiTn =  0.20  --->  O.K !

      ( ). Check longitudinal reinforcement.
           -. phi_f =  0.90
           -. phi_v =  0.90
           -. Mu    =   4943.92 kN-m.
           -. Vu    =   1273.47 kN.
           -. Vs    =   3612.15 kN.
           -. As*fy =   8722.08 kN.
           -. Asfy_min_param1 = (ABS(Vu/phi_v)-0.5*Vs)^2
           -. Asfy_min_param2 = (0.45*Ph*Tu/(2*Ao*phi_v))^2
           -. Asfy_min = ABS(Mu)/(phi_f*dv) +
                         cot(theta)*SQRT( Asfy_min_param1 + Asfy_min_param2 ) =   7556.13 kN.

           -. As*fy >= Asfy_min   --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB = 160- )
           -. Mu      =   1655.6635 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0850 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.13 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.3245 m.
           -. Icr     =      0.0714 m^4.
           -. fss     =    109098.082 KPa.
           -. s       =       0.0966 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.8220 m.
           -. s < sa --->  O.K !
```

( ). Check crack control of bottom reinforcement. (LCB = 160+)
-. Mu = 1388.1261 kN-m.
-. h = 1.0000 m.
-. dc = 0.0850 m.
-. Beta_s = 1+dc/(0.7*(h-dc)) = 1.13 m.
-. Gamma_e = 1.00
-. c_cr = 0.3245 m.
-. Icr = 0.0714 m^4.
-. fss = 91469.008 KPa.
-. s = 0.0966 m.
-. sa = 700*Gamma_e/(Beta_s*fss)-2*dc = 1.0132 m.
-. s < sa ---> O.K !

MIDAS/Civil - RC-Beam Checking [AASHTO-LRFD12] Civil 2020

*.MIDAS/Civil - RC-BEAM Analysis/Design Program.

*.PROJECT :
*.DESIGN CODE : AASHTO-LRFD12, *.UNIT SYSTEM : kN, m
*.MEMBER : Member Type = BEAM, MEMB =117000

*.DESCRIPTION OF BEAM DATA (iSEC = 65) : Viga_120x100
Section Type : Rectangle (RECT)
Beam Length (Span) = 8.501 m.
Section Depth (Hc) = 1.000 m.
Section Width (Bc) = 1.200 m.
Concrete Strength (fc') = 27579.038 KPa.
Main Rebar Strength (fy) = 413685.566 KPa.
Stirrups Strength (fys) = 413685.566 KPa.
Modulus of Elasticity (Es) = 199948023.746 KPa.

*.FORCES AND MOMENTS AT CHECK POINT <I> :
Positive Bending Moment P-Mu = 4835.42 kN-m., LCB =152+
Negative Bending Moment N-Mu = 5123.40 kN-m., LCB =152-
Shear Force Vu = 1310.32 kN. , LCB =152-

*.REINFORCEMENT PATTERN :

Location	i	di(m.)	Rebar	Asi(m^2.)
Top	1	0.085	11-#10	0.00901
Top	2	0.115	11-#10	0.00901
Top	3	0.200	2- #8	0.00102
Top	4	0.300	2- #8	0.00102
Top	5	0.400	2- #8	0.00102
Bottom	1	0.085	11-#10	0.00901
Bottom	2	0.115	11-#10	0.00901
Bottom	3	0.200	2- #8	0.00102
Bottom	4	0.300	2- #8	0.00102
Bottom	5	0.400	2- #8	0.00102

Stirrups : 6.0-#5 @150

[[[*]]] ANALYZE NEGATIVE BENDING MOMENT CAPACITY.

( ). Compute parameter.
-. phi = 0.90
-. Alpha = 0.85
-. Beta = 0.85
-. d = 0.8710 m.

```
     -. ecu   =  0.0030

( ). Compute maximum and minimum reinforcement.
     -. Rhomin1 = (1.2)*Mcr/[ phi*fy*b*d*(d-a/2) ]      =   0.0024
     -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ]        =   0.0261
     -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]               =   0.0024
     -. As_min =  Rhomin * Ag  =     0.0029 m^2.
```

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.932 ---> O.K !

[[[*]]] ANALYZE POSITIVE BENDING MOMENT CAPACITY.

( ). Compute parameter.
-. phi = 0.90
-. Alpha = 0.85
-. Beta = 0.85
-. d = 0.8710 m.
-. ecu = 0.0030

( ). Compute maximum and minimum reinforcement.
-. Rhomin1 = (1.2)*Mcr/[phi*fy*b*d*(d-a/2)] = 0.0024
-. Rhomin2 = 1.33*Mu/[phi*fy*b*d*(d-a/2)] = 0.0241
-. Rhomin = MIN[Rhomin1, Rhomin2] = 0.0024
-. As_min = Rhomin * Ag = 0.0029 m^2.

( ). Check tensile reinforcement.
-. As = 0.0211 m^2.
-. As_min < As ---> O.K !

( ). Check moment capacity.
-. c = 0.3620 m.
-. Cc = 8655.29 kN.
-. Ts = 8702.45 kN.
-. Mr = 5494.28 kN-m.
-. Mu/Mr = 0.880 ---> O.K !

[[[*]]] ANALYZE SHEAR CAPACITY.

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 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2020
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      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0012 m^2.
           -. bv    =   1.20 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.78 m.
           -. theta =  35.91 Deg.   [Clause 5.8.3.4.2]
           -. beta  =   1.94

      ( ). Compute shear strength of concrete.
           -. Vu     =     1310.32 kN.
           -. Vc     = 0.0316*beta*SQRT[fc']*bv*dv =      793.29 kN.
           -. phiVc  = phi * Vc =      713.96 kN.
           -. Vn_lim = 0.25*fc'*bv*dv =     6485.70 kN.

      ( ). Compute stirrup spacing.
           -. Maximum spacing smax = MIN[ 0.8*dv, 24 in ] =    0.610 m.
           -. Vu > phiVc  --->  Required shear reinforcement.
           -.                  smax = MIN[ smax, Av/(0.0316*SQRT(fc')*bv/fys) ] =    0.610 m.
           -. Applied spacing s    =    0.150 m.

      ( ). Compute shear strength of reinforcement.
           -. Vs      = Av*fys*dv*cot(theta) / s =     3582.86 kN.
           -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     5692.41 kN.
           -. Vs      = MIN[ Vs, Vs_lim ] =     3582.86 kN.
           -. phiVs   = phi*Vs =     3224.58 kN.

           -. phiVs > (Vu-phiVc)  --->  O.K !
           -. Using Av/s  =  Vs / (fys*dv*cot(theta)) =   0.0080 m^2/m.

      ( ). Check tension force in the longitudinal reinforcement caused by shear.
           -. phib    =   0.90
           -. phiv    =   0.90
           -. Vs1     =  MIN[ Vs, Vu/phiv ] =     1455.91 kN.
           -. As_req  =  [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta) ] / fy =   0.0200 m^2.
           -. As      =   0.0211 m^2.
           -. As_req < As  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE TORSION CAPACITY.
 ============================================================================

      ( ). Compute torsion parameter.
           -. phi   =   0.90
           -. Acp   =       1.20 m^2.
           -. Pc    =       4.40 m.
           -. Aoh   =       1.00 m^2.
           -. Ao    =  0.85*Aoh =      0.85 m^2.
           -. Ph    =       4.04 m.
           -. Tu    =       -219.52 kN-m.
           -. theta =  35.91 Deg.
           -. Tcr   =  0.125*SQRT(fc')*Acp^2/Pc =       564.12 kN-m.

           -. Tu > 0.25*phi*Tcr =       126.93 kN-m.
               ---> Required torsion checking.
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0012 m^2.
           -. bv    =   1.20 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.78 m.
           -. theta =  35.91 Deg.   [Clause 5.8.3.4.2]
           -. beta  =   1.94
           -. smax  =   0.61
           -. Vs    =       3582.86

      ( ). Compute torsional resistance.
           -. Tu       =    -219.52 kN-m.
           -. At       =     0.0002 m^2.
           -. St       =       0.15 m.
           -. phiTn    =  phi*2*Ao*At*fy*cot(theta)/St =   1170.97 kN-m.

           -. Tu/phiTn =  0.19  --->  O.K !

      ( ). Check longitudinal reinforcement.
           -. phi_f =  0.90
           -. phi_v =  0.90
           -. Mu    =   5123.40 kN-m.
           -. Vu    =   1310.32 kN.
           -. Vs    =   3582.86 kN.
           -. As*fy =   8722.08 kN.
           -. Asfy_min_param1 = (ABS(Vu/phi_v)-0.5*Vs)^2
           -. Asfy_min_param2 = (0.45*Ph*Tu/(2*Ao*phi_v))^2
           -. Asfy_min = ABS(Mu)/(phi_f*dv) +
                         cot(theta)*SQRT( Asfy_min_param1 + Asfy_min_param2 ) =   7700.15 kN.

           -. As*fy >= Asfy_min   --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB = 160- )
           -. Mu      =   1707.3169 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0850 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.13 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.3245 m.
           -. Icr     =      0.0714 m^4.
           -. fss     =    112501.726 KPa.
           -. s       =       0.0966 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.7920 m.
           -. s < sa --->  O.K !
```

( ). Check crack control of bottom reinforcement. (LCB = 160+)
-. Mu = 1439.9188 kN-m.
-. h = 1.0000 m.
-. dc = 0.0850 m.
-. Beta_s = 1+dc/(0.7*(h-dc)) = 1.13 m.
-. Gamma_e = 1.00
-. c_cr = 0.3245 m.
-. Icr = 0.0714 m^4.
-. fss = 94881.828 KPa.
-. s = 0.0966 m.
-. sa = 700*Gamma_e/(Beta_s*fss)-2*dc = 0.9706 m.
-. s < sa ---> O.K !

GOBIERNO DE LA CIUDAD DE MÉXICO **GOBIERNO DE LA CIUDAD DE MÉXICO** SECRETARÍA DE OBRAS Y SERVICIOS Dirección General de Obras Para el Transporte	**CONTRATO No. DGOT-IR-F-4-004-2020** **PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN – AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.** **TRAMO: AV. MOLINO DEL REY 1A. SECCIÓN -AV. COMOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.**	

APÉNDICE 10. DISEÑO DE PILAS

APÉNCIDE DE MEMORIA: DGOT-20-EST-III-0116-00317-M-00	FECHA: JULIO 2021	HOJA: 1 de 3722
TITULO: **APÉNDICE 10. DISEÑO DE PILAS**	TRAMO: **AV. MOLINO DEL REY 1ª SECCIÓN – AV. DE LOS COMPOSITORES 2ª SECC. DEL BOSQUE DE CHAPULTEPEC**	
ADMINISTRADOR ÚNICO **FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.:** **ING. DAVID SEVERIANO QUINTERO CAMPOS**	**DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE:** **ING. HUGO FLORES SÁNCHEZ**	
APROBÓ: GERENTE DE PROYECTO INTEGRAL **FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.:** **M. EN I. DANIEL PÉREZ BELLO**	**DIRECTOR DE OBRA ELECTROMECÁNICA:** **ING. ALBERTO SÁNCHEZ JUAREZ**	
REVISÓ: SUPERINTENDENTE DE PROYECTO INTEGRAL FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.: **M.V.T. GERMÁN GARCÍA DEHEZA**	**SUBDIRECTOR DE OBRA ELECTROMECÁNICA "A1":** **ING. FELIPE DE JESÚS HERRERA BATRES**	
ELABORÓ: ESPECIALISTA EN ESTRUCTURAS FREDEL INGENIERÍA Y ARQUITECTURA, S.A. DE C.V.:	**JUD DE SUPERVISIÓN Y CONTROL DE OBRA ELECTROMECÁNICA "A2", RESIDENTE DE OBRA:** **ARQ. MARCELA ERNESTINA YÁÑEZ VÉRTIZ**	

FICHA DE SEGUIMIENTO DE LAS REVISIONES

No. Rev.	Descripción de la Modificación	Fecha

DIRECCIÓN GENERAL DE OBRAS PARA EL TRANSPORTE

CONTRATO NO: DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN – AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TRAMO:

AV. MOLINO DEL REY 1A. SECCIÓN -AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

Í N D I C E

APÉNDICE

10. DISEÑO DE PILAS 4

10.1. CALZADA PEATONAL TRAMO 1 4

10.2. CALZADA PEATONAL TRAMO 2 2186

APÉNDICE:

10. DISEÑO DE PILAS

A continuación, se incluyen los listados de comprobación de las pilas de concreto, para los modelos de cálculo del tramo 1 y tramo 2 de la calzada peatonal.

10.1. CALZADA PEATONAL TRAMO 1

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
==========================================================================================


       +============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
       |  MIDAS/Civil - Design & checking system for windows        |
       +============================================================+
       |  RC-Member(Beam or Column) Analysis and Design             |
       |  Based On  AASHTO-LRFD16, AASHTO-LRFD12, AASHTO-LRFD07,    |
       |            AASHTO-LRFD02, AASHTO-LFD96, ACI318-02,         |
       |            CSA-S6-00, CSA-S6-14, Eurocode2-2:05,           |
       |            SNiP 2.05.03-84*, SP 35.13330.2011,             |
       |            SNiP 2.05.03-84*(MKS), SP 35.13330.2011(MKS),   |
       |            IRC:21-2000, IRC:112-2011                       |
       |                                                            |
       |                                          (c)SINCE 1989  |
       +============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)  |
       |  MIDAS IT Design Development Team                          |
       +============================================================+
       |            HomePage : www.MidasUser.com                    |
       +============================================================+
       |  MIDAS/Civil  Version 8.8.5                                |
       +============================================================+


    *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
------------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
------------------------------------------------------------------------------------------
     65+  1       PL01d-ext_( 4.300) +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300)
            +    PL01i-int_( 4.300) +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300)
            +    PL02d-int_( 4.300) +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300)
            +    PL03i-ext_( 4.300) +    PL03d-int_( 4.300) +    PL03i-int_( 4.300)
            +    PL04d-ext_( 4.300) +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300)
            +    PL04i-int_( 4.300) +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300)
            +    PL05d-int_( 4.300) +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300)
            +    PL06i-ext_( 4.300) +    PL06d-int_( 4.300) +    PL06i-int_( 4.300)
            +    PL07d-ext_( 4.300) +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300)
            +    PL07i-int_( 4.300) +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300)
            +    PL08d-int_( 4.300) +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300)
            +    PL09i-ext_( 4.300) +    PL09d-int_( 4.300) +    PL09i-int_( 4.300)
            +    PL10d-ext_( 4.300) +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300)
            +    PL10i-int_( 4.300)
     65-  1       PL01d-ext_( 4.300) +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300)
            +    PL01i-int_( 4.300) +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300)
            +    PL02d-int_( 4.300) +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300)
            +    PL03i-ext_( 4.300) +    PL03d-int_( 4.300) +    PL03i-int_( 4.300)
            +    PL04d-ext_( 4.300) +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300)
            +    PL04i-int_( 4.300) +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300)
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+    PL06i-ext_( 4.300) +    PL06d-int_( 4.300) +    PL06i-int_( 4.300)
+    PL07d-ext_( 4.300) +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300)
+    PL07i-int_( 4.300) +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300)
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            +    PL09i-ext_( 4.300) +    PL09d-int_( 4.300) +    PL09i-int_( 4.300)
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            +    PL10i-int_( 4.300)
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            +    PL01i-int_( 7.190) +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190)
            +    PL02d-int_( 7.190) +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190)
            +    PL03i-ext_( 7.190) +    PL03d-int_( 7.190) +    PL03i-int_( 7.190)
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            +    PL10i-int_( 7.190)
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            +    PL10i-int_( 7.190)
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            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
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            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
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            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
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            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
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            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   149-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +        TU_ENV( 1.200)
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            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   151+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
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            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
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            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
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            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
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            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_1.0X/0.3Y_ENV( 1.000)
    152+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_0.3X/1.0Y_ENV( 1.000)
    152-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
            +    PL03d-int_( 4.300) +    PL03i-int_( 4.300) +    PL04d-ext_( 4.300)
            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
            +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300) +    PL05d-int_( 4.300)
            +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300) +    PL06i-ext_( 4.300)
            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
            +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300) +    PL08d-int_( 4.300)
            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_0.3X/1.0Y_ENV( 1.000)
    153+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
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            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
   153-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-int_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
```

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111102,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1521.26      -349.37      -242.97     -1297.67     -1501.18
           ------------------------------------------------------------------------------
            DL+LL+Others     1521.26      -349.37      -242.97     -1297.67     -1501.18
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      242.97 kN-m.
           -. End Moments (My2) =      349.37 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -242.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -242.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1297.67 kN-m.
          -. End Moments (Mz2) =     1501.18 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1501.18 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1501.18 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =      5226.969 kN.
           -. Mry        =       842.437 kN-m.
           -. Mrz        =      5154.826 kN-m.
           -. Mr         =      5223.211 kN-m.
           -. Pu/Pr      =   0.291  --->  O.K !
           -. Muy/Mry    =   0.288  --->  O.K !
           -. Muz/Mrz    =   0.291  --->  O.K !
           -. Mu/Mr      =   0.291  --->  O.K !
           -. Ratio      =   0.291  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       1638.10 kN.
           -. Vuz    =        993.54 kN.
           -. Muy    =       -417.79 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  32.04 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.91

           -. Vuy    =        414.74 kN.
           -. Muz    =      -1118.04 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.29 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.81
```

( ). Compute shear strength of concrete.
-. Vuz = 993.54 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1313.17 kN.
-. phiVcz = phi * Vcz = 1181.86 kN.

-. Vuy = 414.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1271.38 kN.
-. phiVcy = phi * Vcy = 1144.24 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2161.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5835.31 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2161.63 kN.
-. phiVsz = phi*Vsz = 1945.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2140.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5877.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2140.53 kN.
-. phiVsy = phi*Vsy = 1926.48 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1076.635 kN.
-. Vr = 3070.723 kN.
-. Ratio = Vu / Vr = 0.351 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1196.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1196.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111103,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1537.94      -242.97      -456.50     -1501.18     -1664.25
           ------------------------------------------------------------------------------
            DL+LL+Others     1537.94      -242.97      -456.50     -1501.18     -1664.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      242.97 kN-m.
           -. End Moments (My2) =      456.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -456.50 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -456.50 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1501.18 kN-m.
          -. End Moments (Mz2) =     1664.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1664.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1664.25 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4680.165 kN.
          -. Mry        =      1380.358 kN-m.
          -. Mrz        =      5038.136 kN-m.
          -. Mr         =      5223.811 kN-m.
          -. Pu/Pr      =   0.329  --->  O.K !
          -. Muy/Mry    =   0.331  --->  O.K !
          -. Muz/Mrz    =   0.330  --->  O.K !
          -. Mu/Mr      =   0.331  --->  O.K !
          -. Ratio      =   0.331  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1654.80 kN.
          -. Vuz    =        861.92 kN.
          -. Muy    =       -810.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.87

          -. Vuy    =        359.70 kN.
          -. Muz    =      -1134.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.78
```

( ). Compute shear strength of concrete.
-. Vuz = 861.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1297.95 kN.
-. phiVcz = phi * Vcz = 1168.15 kN.

-. Vuy = 359.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1255.93 kN.
-. phiVcy = phi * Vcy = 1130.33 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2154.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5850.54 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2154.07 kN.
-. phiVsz = phi*Vsz = 1938.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2132.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5892.56 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2132.45 kN.
-. phiVsy = phi*Vsy = 1919.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 933.960 kN.
-. Vr = 3049.538 kN.
-. Ratio = Vu / Vr = 0.306 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1037.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1037.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111104,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1554.61      -456.50      -738.04     -1664.25     -1787.38
           ---------------------------------------------------------------------------
            DL+LL+Others     1554.61      -456.50      -738.04     -1664.25     -1787.38
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      456.50 kN-m.
           -. End Moments (My2) =      738.04 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -738.04 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -738.04 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1664.25 kN-m.
          -. End Moments (Mz2) =     1787.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1787.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1787.38 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4214.264 kN.
          -. Mry        =      2001.499 kN-m.
          -. Mrz        =      4822.183 kN-m.
          -. Mr         =      5221.058 kN-m.
          -. Pu/Pr      =   0.369  --->  O.K !
          -. Muy/Mry    =   0.369  --->  O.K !
          -. Muz/Mrz    =   0.371  --->  O.K !
          -. Mu/Mr      =   0.371  --->  O.K !
          -. Ratio      =   0.371  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1671.49 kN.
          -. Vuz    =        731.51 kN.
          -. Muy    =      -1175.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.27 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.82

          -. Vuy    =        307.05 kN.
          -. Muz    =      -1139.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.73
```

( ). Compute shear strength of concrete.
-. Vuz = 731.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1275.23 kN.
-. phiVcz = phi * Vcz = 1147.70 kN.

-. Vuy = 307.05 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1232.90 kN.
-. phiVcy = phi * Vcy = 1109.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2142.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5873.26 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2142.52 kN.
-. phiVsz = phi*Vsz = 1928.27 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2120.12 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5915.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2120.12 kN.
-. phiVsy = phi*Vsy = 1908.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 793.338 kN.
-. Vr = 3017.718 kN.
-. Ratio = Vu / Vr = 0.263 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 881.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 881.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111105,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1571.29      -738.04      -982.48     -1787.38     -1871.26
           ---------------------------------------------------------------------------
            DL+LL+Others     1571.29      -738.04      -982.48     -1787.38     -1871.26
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      738.04 kN-m.
           -. End Moments (My2) =      982.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -982.48 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -982.48 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1787.38 kN-m.
          -. End Moments (Mz2) =     1871.26 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1871.26 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1871.26 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      3902.942 kN.
          -. Mry        =      2424.812 kN-m.
          -. Mrz        =      4621.753 kN-m.
          -. Mr         =      5219.226 kN-m.
          -. Pu/Pr      =   0.403  --->  O.K !
          -. Muy/Mry    =   0.405  --->  O.K !
          -. Muz/Mrz    =   0.405  --->  O.K !
          -. Mu/Mr      =   0.405  --->  O.K !
          -. Ratio      =   0.405  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1688.18 kN.
          -. Vuz    =        603.71 kN.
          -. Muy    =      -1481.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        257.69 kN.
          -. Muz    =      -1132.77 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.68 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.68
```

( ). Compute shear strength of concrete.
-. Vuz = 603.71 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1255.45 kN.
-. phiVcz = phi * Vcz = 1129.90 kN.

-. Vuy = 257.69 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1212.89 kN.
-. phiVcy = phi * Vcy = 1091.60 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2132.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5893.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2132.20 kN.
-. phiVsz = phi*Vsz = 1918.98 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2109.11 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5935.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2109.11 kN.
-. phiVsy = phi*Vsy = 1898.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 656.410 kN.
-. Vr = 2989.799 kN.
-. Ratio = Vu / Vr = 0.220 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 729.34 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 729.34 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111106,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            665.09       990.87      1175.43      1769.64      1874.82
           ---------------------------------------------------------------------------
            DL+LL+Others      665.09       990.87      1175.43      1769.64      1874.82
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      990.87 kN-m.
           -. End Moments (My2) =     1175.43 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1175.43 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1175.43 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1769.64 kN-m.
          -. End Moments (Mz2) =     1874.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1874.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1874.82 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1538.980 kN.
          -. Mry        =      2705.549 kN-m.
          -. Mrz        =      4318.020 kN-m.
          -. Mr         =      5095.615 kN-m.
          -. Pu/Pr      =   0.432  --->  O.K !
          -. Muy/Mry    =   0.434  --->  O.K !
          -. Muz/Mrz    =   0.434  --->  O.K !
          -. Mu/Mr      =   0.434  --->  O.K !
          -. Ratio      =   0.434  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1704.87 kN.
          -. Vuz    =        479.88 kN.
          -. Muy    =      -1725.61 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =        212.55 kN.
          -. Muz    =      -1113.66 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 479.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1241.84 kN.
-. phiVcz = phi * Vcz = 1117.66 kN.

-. Vuy = 212.55 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1199.14 kN.
-. phiVcy = phi * Vcy = 1079.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2124.95 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5906.64 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2124.95 kN.
-. phiVsz = phi*Vsz = 1912.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2101.38 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5949.35 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2101.38 kN.
-. phiVsy = phi*Vsy = 1891.24 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 524.842 kN.
-. Vr = 2970.465 kN.
-. Ratio = Vu / Vr = 0.177 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 583.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 583.16 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0047 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111107,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            677.07      1175.43      1317.44      1874.82      1938.88
           ------------------------------------------------------------------------------
            DL+LL+Others      677.07      1175.43      1317.44      1874.82      1938.88
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1175.43 kN-m.
           -. End Moments (My2) =     1317.44 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1317.44 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1317.44 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1874.82 kN-m.
          -. End Moments (Mz2) =     1938.88 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1938.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1938.88 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1461.334 kN.
          -. Mry        =      2869.895 kN-m.
          -. Mrz        =      4208.254 kN-m.
          -. Mr         =      5093.692 kN-m.
          -. Pu/Pr      =   0.463  --->  O.K !
          -. Muy/Mry    =   0.459  --->  O.K !
          -. Muz/Mrz    =   0.461  --->  O.K !
          -. Mu/Mr      =   0.463  --->  O.K !
          -. Ratio      =   0.463  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1721.56 kN.
          -. Vuz    =        361.34 kN.
          -. Muy    =      -1909.99 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73

          -. Vuy    =        172.45 kN.
          -. Muz    =      -1084.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 361.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1234.99 kN.
-. phiVcz = phi * Vcz = 1111.49 kN.

-. Vuy = 172.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1192.22 kN.
-. phiVcy = phi * Vcy = 1073.00 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2121.25 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5913.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2121.25 kN.
-. phiVsz = phi*Vsz = 1909.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2097.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5956.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2097.44 kN.
-. phiVsy = phi*Vsy = 1887.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 400.384 kN.
-. Vr = 2960.688 kN.
-. Ratio = Vu / Vr = 0.135 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 444.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 444.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0049 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0049 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0049 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111108,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            689.04      1317.44      1420.63      1938.88      1969.28
           ---------------------------------------------------------------------------
            DL+LL+Others      689.04      1317.44      1420.63      1938.88      1969.28
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1317.44 kN-m.
           -. End Moments (My2) =     1420.63 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1420.63 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1420.63 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1938.88 kN-m.
          -. End Moments (Mz2) =     1969.28 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1969.28 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1969.28 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1458.499 kN.
          -. Mry        =      2993.580 kN-m.
          -. Mrz        =      4124.975 kN-m.
          -. Mr         =      5096.758 kN-m.
          -. Pu/Pr      =   0.472  --->  O.K !
          -. Muy/Mry    =   0.475  --->  O.K !
          -. Muz/Mrz    =   0.477  --->  O.K !
          -. Mu/Mr      =   0.477  --->  O.K !
          -. Ratio      =   0.477  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1738.25 kN.
          -. Vuz    =        249.37 kN.
          -. Muy    =      -2039.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73

          -. Vuy    =        138.34 kN.
          -. Muz    =      -1049.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 249.37 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1234.11 kN.
-. phiVcz = phi * Vcz = 1110.70 kN.

-. Vuy = 138.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1191.34 kN.
-. phiVcy = phi * Vcy = 1072.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2120.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5914.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2120.78 kN.
-. phiVsz = phi*Vsz = 1908.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2096.93 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5957.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2096.93 kN.
-. phiVsy = phi*Vsy = 1887.24 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 285.173 kN.
-. Vr = 2959.439 kN.
-. Ratio = Vu / Vr = 0.096 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 316.86 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 316.86 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0049 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0049 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0049 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111109,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            701.01      1420.63      1488.20      1969.28      1962.30
           ------------------------------------------------------------------------------
            DL+LL+Others      701.01      1420.63      1488.20      1969.28      1962.30
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1420.63 kN-m.
           -. End Moments (My2) =     1488.20 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1488.20 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1488.20 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1962.30 kN-m.
          -. End Moments (Mz2) =     1969.28 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1962.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1962.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1437.215 kN.
          -. Mry        =      3077.365 kN-m.
          -. Mrz        =      4053.811 kN-m.
          -. Mr         =      5089.554 kN-m.
          -. Pu/Pr      =   0.488  --->  O.K !
          -. Muy/Mry    =   0.484  --->  O.K !
          -. Muz/Mrz    =   0.484  --->  O.K !
          -. Mu/Mr      =   0.488  --->  O.K !
          -. Ratio      =   0.488  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1754.94 kN.
          -. Vuz    =        145.24 kN.
          -. Muy    =      -2119.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =        130.74 kN.
          -. Muz    =      -1003.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 145.24 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1237.20 kN.
-. phiVcz = phi * Vcz = 1113.48 kN.

-. Vuy = 130.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1194.45 kN.
-. phiVcy = phi * Vcy = 1075.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2122.45 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5911.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2122.45 kN.
-. phiVsz = phi*Vsz = 1910.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2098.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5954.03 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2098.71 kN.
-. phiVsy = phi*Vsy = 1888.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 195.418 kN.
-. Vr = 2963.850 kN.
-. Ratio = Vu / Vr = 0.066 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 217.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 217.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0049 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0049 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0049 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111110,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            701.00      1488.20      1519.26      1962.30      1922.48
           ---------------------------------------------------------------------------
            DL+LL+Others      701.00      1488.20      1519.26      1962.30      1922.48
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1488.20 kN-m.
           -. End Moments (My2) =     1519.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1488.20 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1488.20 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1922.48 kN-m.
          -. End Moments (Mz2) =     1962.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1962.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1962.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1437.215 kN.
          -. Mry        =      3077.365 kN-m.
          -. Mrz        =      4053.811 kN-m.
          -. Mr         =      5089.554 kN-m.
          -. Pu/Pr      =   0.488  --->  O.K !
          -. Muy/Mry    =   0.484  --->  O.K !
          -. Muz/Mrz    =   0.484  --->  O.K !
          -. Mu/Mr      =   0.488  --->  O.K !
          -. Ratio      =   0.488  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1638.01 kN.
          -. Vuz    =         66.90 kN.
          -. Muy    =      -1526.46 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =        155.72 kN.
          -. Muz    =      -1874.63 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 66.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1237.31 kN.
-. phiVcz = phi * Vcz = 1113.58 kN.

-. Vuy = 155.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1194.56 kN.
-. phiVcy = phi * Vcy = 1075.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2122.51 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5911.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2122.51 kN.
-. phiVsz = phi*Vsz = 1910.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2098.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5953.93 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2098.77 kN.
-. phiVsy = phi*Vsy = 1888.90 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 169.485 kN.
-. Vr = 2964.001 kN.
-. Ratio = Vu / Vr = 0.057 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 188.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 188.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111111,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            712.97      1519.26      1517.09      1922.48      1854.28
           ---------------------------------------------------------------------------
            DL+LL+Others      712.97      1519.26      1517.09      1922.48      1854.28
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1517.09 kN-m.
           -. End Moments (My2) =     1519.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1519.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1519.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1854.28 kN-m.
          -. End Moments (Mz2) =     1922.48 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1922.48 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1922.48 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1488.321 kN.
          -. Mry        =      3159.357 kN-m.
          -. Mrz        =      3995.451 kN-m.
          -. Mr         =      5093.639 kN-m.
          -. Pu/Pr      =   0.479  --->  O.K !
          -. Muy/Mry    =   0.481  --->  O.K !
          -. Muz/Mrz    =   0.481  --->  O.K !
          -. Mu/Mr      =   0.481  --->  O.K !
          -. Ratio      =   0.481  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1654.68 kN.
          -. Vuz    =         31.42 kN.
          -. Muy    =      -1563.99 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =        196.62 kN.
          -. Muz    =      -1805.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 31.42 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1236.62 kN.
-. phiVcz = phi * Vcz = 1112.96 kN.

-. Vuy = 196.62 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1193.86 kN.
-. phiVcy = phi * Vcy = 1074.48 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2122.13 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5911.87 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2122.13 kN.
-. phiVsz = phi*Vsz = 1909.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2098.38 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5954.62 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2098.38 kN.
-. phiVsy = phi*Vsy = 1888.54 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 199.117 kN.
-. Vr = 2963.018 kN.
-. Ratio = Vu / Vr = 0.067 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 221.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 221.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111112,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            724.94      1517.09      1485.45      1854.28      1761.83
           ---------------------------------------------------------------------------
            DL+LL+Others      724.94      1517.09      1485.45      1854.28      1761.83
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1485.45 kN-m.
           -. End Moments (My2) =     1517.09 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1517.09 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1517.09 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1761.83 kN-m.
          -. End Moments (Mz2) =     1854.28 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1854.28 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1854.28 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1536.557 kN.
          -. Mry        =      3228.225 kN-m.
          -. Mrz        =      3945.048 kN-m.
          -. Mr         =      5097.533 kN-m.
          -. Pu/Pr      =   0.472  --->  O.K !
          -. Muy/Mry    =   0.470  --->  O.K !
          -. Muz/Mrz    =   0.470  --->  O.K !
          -. Mu/Mr      =   0.472  --->  O.K !
          -. Ratio      =   0.472  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1671.36 kN.
          -. Vuz    =         66.36 kN.
          -. Muy    =      -1566.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =        230.65 kN.
          -. Muz    =      -1715.37 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 66.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1240.43 kN.
-. phiVcz = phi * Vcz = 1116.39 kN.

-. Vuy = 230.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1197.71 kN.
-. phiVcy = phi * Vcy = 1077.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2124.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5908.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2124.19 kN.
-. phiVsz = phi*Vsz = 1911.77 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2100.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5950.77 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2100.57 kN.
-. phiVsy = phi*Vsy = 1890.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 240.008 kN.
-. Vr = 2968.456 kN.
-. Ratio = Vu / Vr = 0.081 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 266.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 266.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111113,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            736.92      1485.45      1428.32      1761.83      1649.34
           ------------------------------------------------------------------------------
            DL+LL+Others      736.92      1485.45      1428.32      1761.83      1649.34
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1428.32 kN-m.
           -. End Moments (My2) =     1485.45 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1485.45 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1485.45 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1649.34 kN-m.
          -. End Moments (Mz2) =     1761.83 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1761.83 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1761.83 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1628.865 kN.
          -. Mry        =      3289.873 kN-m.
          -. Mrz        =      3903.489 kN-m.
          -. Mr         =      5104.948 kN-m.
          -. Pu/Pr      =   0.452  --->  O.K !
          -. Muy/Mry    =   0.452  --->  O.K !
          -. Muz/Mrz    =   0.451  --->  O.K !
          -. Mu/Mr      =   0.452  --->  O.K !
          -. Ratio      =   0.452  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1688.03 kN.
          -. Vuz    =        116.56 kN.
          -. Muy    =      -1537.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.77

          -. Vuy    =        257.44 kN.
          -. Muz    =      -1607.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67
```

( ). Compute shear strength of concrete.
-. Vuz = 116.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1249.44 kN.
-. phiVcz = phi * Vcz = 1124.50 kN.

-. Vuy = 257.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1206.82 kN.
-. phiVcy = phi * Vcy = 1086.14 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2129.01 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5899.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2129.01 kN.
-. phiVsz = phi*Vsz = 1916.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2105.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5941.67 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2105.71 kN.
-. phiVsy = phi*Vsy = 1895.14 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 282.600 kN.
-. Vr = 2981.276 kN.
-. Ratio = Vu / Vr = 0.095 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 314.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 314.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0048 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111114,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            748.90      1428.32      1349.84      1649.34      1520.06
           ---------------------------------------------------------------------------
            DL+LL+Others      748.90      1428.32      1349.84      1649.34      1520.06
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1349.84 kN-m.
           -. End Moments (My2) =     1428.32 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1428.32 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1428.32 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1520.06 kN-m.
          -. End Moments (Mz2) =     1649.34 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1649.34 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1649.34 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1764.465 kN.
          -. Mry        =      3346.554 kN-m.
          -. Mrz        =      3869.256 kN-m.
          -. Mr         =      5115.717 kN-m.
          -. Pu/Pr      =   0.424  --->  O.K !
          -. Muy/Mry    =   0.427  --->  O.K !
          -. Muz/Mrz    =   0.426  --->  O.K !
          -. Mu/Mr      =   0.427  --->  O.K !
          -. Ratio      =   0.427  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1704.70 kN.
          -. Vuz    =        159.93 kN.
          -. Muy    =      -1481.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.34 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =        276.85 kN.
          -. Muz    =      -1484.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.70
```

( ). Compute shear strength of concrete.
-. Vuz = 159.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1264.08 kN.
-. phiVcz = phi * Vcz = 1137.67 kN.

-. Vuy = 276.85 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1221.62 kN.
-. phiVcy = phi * Vcy = 1099.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2136.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5884.40 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2136.73 kN.
-. phiVsz = phi*Vsz = 1923.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2113.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5926.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2113.95 kN.
-. phiVsy = phi*Vsy = 1902.55 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 319.727 kN.
-. Vr = 3002.012 kN.
-. Ratio = Vu / Vr = 0.107 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 355.25 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 355.25 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111115,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            760.87      1349.84      1254.18      1520.06      1378.45
           ------------------------------------------------------------------------------
            DL+LL+Others      760.87      1349.84      1254.18      1520.06      1378.45
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1254.18 kN-m.
           -. End Moments (My2) =     1349.84 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1349.84 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1349.84 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1378.45 kN-m.
          -. End Moments (Mz2) =     1520.06 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1520.06 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1520.06 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1905.033 kN.
          -. Mry        =      3401.004 kN-m.
          -. Mrz        =      3834.072 kN-m.
          -. Mr         =      5125.128 kN-m.
          -. Pu/Pr      =   0.399  --->  O.K !
          -. Muy/Mry    =   0.397  --->  O.K !
          -. Muz/Mrz    =   0.396  --->  O.K !
          -. Mu/Mr      =   0.399  --->  O.K !
          -. Ratio      =   0.399  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1721.37 kN.
          -. Vuz    =        195.05 kN.
          -. Muy    =      -1403.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        289.06 kN.
          -. Muz    =      -1350.32 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 195.05 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1284.36 kN.
-. phiVcz = phi * Vcz = 1155.93 kN.

-. Vuy = 289.06 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1242.16 kN.
-. phiVcy = phi * Vcy = 1117.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2147.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5864.12 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2147.20 kN.
-. phiVsz = phi*Vsz = 1932.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2125.12 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5906.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2125.12 kN.
-. phiVsy = phi*Vsy = 1912.61 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 348.711 kN.
-. Vr = 3030.550 kN.
-. Ratio = Vu / Vr = 0.115 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 387.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 387.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111116,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            772.85      1254.18      1145.50      1378.45      1228.87
           ------------------------------------------------------------------------------
            DL+LL+Others      772.85      1254.18      1145.50      1378.45      1228.87
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1145.50 kN-m.
           -. End Moments (My2) =     1254.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1254.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1254.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1228.87 kN-m.
          -. End Moments (Mz2) =     1378.45 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1378.45 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1378.45 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2148.854 kN.
          -. Mry        =      3461.042 kN-m.
          -. Mrz        =      3798.484 kN-m.
          -. Mr         =      5138.803 kN-m.
          -. Pu/Pr      =   0.360  --->  O.K !
          -. Muy/Mry    =   0.362  --->  O.K !
          -. Muz/Mrz    =   0.363  --->  O.K !
          -. Mu/Mr      =   0.363  --->  O.K !
          -. Ratio      =   0.363  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1738.04 kN.
          -. Vuz    =        222.15 kN.
          -. Muy    =      -1306.46 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90

          -. Vuy    =        295.55 kN.
          -. Muz    =      -1208.55 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.81
```

( ). Compute shear strength of concrete.
-. Vuz = 222.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1309.78 kN.
-. phiVcz = phi * Vcz = 1178.81 kN.

-. Vuy = 295.55 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1267.94 kN.
-. phiVcy = phi * Vcy = 1141.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2159.96 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5838.70 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2159.96 kN.
-. phiVsz = phi*Vsz = 1943.97 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2138.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5880.55 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2138.74 kN.
-. phiVsy = phi*Vsy = 1924.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 369.728 kN.
-. Vr = 3066.017 kN.
-. Ratio = Vu / Vr = 0.121 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 410.81 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 410.81 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111117,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            667.78      1530.06      1365.82       685.65       602.72
           ------------------------------------------------------------------------------
            DL+LL+Others      667.78      1530.06      1365.82       685.65       602.72
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1365.82 kN-m.
           -. End Moments (My2) =     1530.06 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1530.06 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1530.06 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      602.72 kN-m.
          -. End Moments (Mz2) =      685.65 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      685.65 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      685.65 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2053.135 kN.
          -. Mry        =      4683.705 kN-m.
          -. Mrz        =      2100.593 kN-m.
          -. Mr         =      5133.184 kN-m.
          -. Pu/Pr      =   0.325  --->  O.K !
          -. Muy/Mry    =   0.327  --->  O.K !
          -. Muz/Mrz    =   0.326  --->  O.K !
          -. Mu/Mr      =   0.327  --->  O.K !
          -. Ratio      =   0.327  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1754.71 kN.
          -. Vuz    =        241.61 kN.
          -. Muy    =      -1195.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97

          -. Vuy    =        295.45 kN.
          -. Muz    =      -1062.79 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 241.61 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1340.06 kN.
-. phiVcz = phi * Vcz = 1206.05 kN.

-. Vuy = 295.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1298.71 kN.
-. phiVcy = phi * Vcy = 1168.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2174.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5808.43 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2174.66 kN.
-. phiVsz = phi*Vsz = 1957.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2154.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5849.78 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2154.45 kN.
-. phiVsy = phi*Vsy = 1939.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 381.665 kN.
-. Vr = 3107.845 kN.
-. Ratio = Vu / Vr = 0.123 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 424.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 424.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111118,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            679.75      1365.82      1195.75       602.72       519.83
           ---------------------------------------------------------------------------
            DL+LL+Others      679.75      1365.82      1195.75       602.72       519.83
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1195.75 kN-m.
           -. End Moments (My2) =     1365.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1365.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1365.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      519.83 kN-m.
          -. End Moments (Mz2) =      602.72 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      602.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      602.72 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2365.469 kN.
          -. Mry        =      4711.426 kN-m.
          -. Mrz        =      2087.587 kN-m.
          -. Mr         =      5153.209 kN-m.
          -. Pu/Pr      =   0.287  --->  O.K !
          -. Muy/Mry    =   0.290  --->  O.K !
          -. Muz/Mrz    =   0.289  --->  O.K !
          -. Mu/Mr      =   0.290  --->  O.K !
          -. Ratio      =   0.290  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1771.38 kN.
          -. Vuz    =        253.85 kN.
          -. Muy    =      -1074.96 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        289.01 kN.
          -. Muz    =       -916.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 253.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1374.69 kN.
-. phiVcz = phi * Vcz = 1237.22 kN.

-. Vuy = 289.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1333.99 kN.
-. phiVcy = phi * Vcy = 1200.59 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2190.85 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5773.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2190.85 kN.
-. phiVsz = phi*Vsz = 1971.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2171.76 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5814.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2171.76 kN.
-. phiVsy = phi*Vsy = 1954.58 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 384.666 kN.
-. Vr = 3155.174 kN.
-. Ratio = Vu / Vr = 0.122 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 427.41 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 427.41 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111119,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1905.12     -1238.94     -1063.56      -370.93      -303.15
           ------------------------------------------------------------------------------
            DL+LL+Others     1905.12     -1238.94     -1063.56      -370.93      -303.15
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1063.56 kN-m.
           -. End Moments (My2) =     1238.94 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1238.94 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1238.94 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      303.15 kN-m.
          -. End Moments (Mz2) =      370.93 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -370.93 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -370.93 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7508.707 kN.
          -. Mry        =      4879.251 kN-m.
          -. Mrz        =      1464.324 kN-m.
          -. Mr         =      5094.245 kN-m.
          -. Pu/Pr      =   0.254  --->  O.K !
          -. Muy/Mry    =   0.254  --->  O.K !
          -. Muz/Mrz    =   0.253  --->  O.K !
          -. Mu/Mr      =   0.254  --->  O.K !
          -. Ratio      =   0.254  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1905.12 kN.
          -. Vuz    =        350.98 kN.
          -. Muy    =      -1238.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.07

          -. Vuy    =        140.09 kN.
          -. Muz    =       -370.93 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.98
```

( ). Compute shear strength of concrete.
-. Vuz = 350.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1388.34 kN.
-. phiVcz = phi * Vcz = 1249.50 kN.

-. Vuy = 140.09 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1347.92 kN.
-. phiVcy = phi * Vcy = 1213.13 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2197.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5760.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2197.05 kN.
-. phiVsz = phi*Vsz = 1977.35 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2178.40 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5800.56 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2178.40 kN.
-. phiVsy = phi*Vsy = 1960.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 377.909 kN.
-. Vr = 3173.688 kN.
-. Ratio = Vu / Vr = 0.119 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 419.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 419.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111120,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1921.80     -1063.56      -892.55      -303.15      -241.56
           ------------------------------------------------------------------------------
            DL+LL+Others     1921.80     -1063.56      -892.55      -303.15      -241.56
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      892.55 kN-m.
           -. End Moments (My2) =     1063.56 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1063.56 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1063.56 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      241.56 kN-m.
          -. End Moments (Mz2) =      303.15 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -303.15 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -303.15 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8575.684 kN.
          -. Mry        =      4758.537 kN-m.
          -. Mrz        =      1359.086 kN-m.
          -. Mr         =      4948.817 kN-m.
          -. Pu/Pr      =   0.224  --->  O.K !
          -. Muy/Mry    =   0.224  --->  O.K !
          -. Muz/Mrz    =   0.223  --->  O.K !
          -. Mu/Mr      =   0.224  --->  O.K !
          -. Ratio      =   0.224  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1921.80 kN.
          -. Vuz    =        342.18 kN.
          -. Muy    =      -1063.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.42 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.16

          -. Vuy    =        127.52 kN.
          -. Muz    =       -303.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.07
```

( ). Compute shear strength of concrete.
-. Vuz = 342.18 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1428.56 kN.
-. phiVcz = phi * Vcz = 1285.70 kN.

-. Vuy = 127.52 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1389.06 kN.
-. phiVcy = phi * Vcy = 1250.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2214.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5719.93 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2214.78 kN.
-. phiVsz = phi*Vsz = 1993.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2197.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5759.43 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2197.37 kN.
-. phiVsy = phi*Vsy = 1977.64 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 365.171 kN.
-. Vr = 3227.790 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 405.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 405.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111121,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1938.48      -892.55      -730.65      -241.56      -186.96
           ---------------------------------------------------------------------------
            DL+LL+Others     1938.48      -892.55      -730.65      -241.56      -186.96
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      730.65 kN-m.
           -. End Moments (My2) =      892.55 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -892.55 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -892.55 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      186.96 kN-m.
          -. End Moments (Mz2) =      241.56 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -241.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -241.56 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10159.267 kN.
          -. Mry        =      4653.574 kN-m.
          -. Mrz        =      1261.036 kN-m.
          -. Mr         =      4821.407 kN-m.
          -. Pu/Pr      =   0.191  --->  O.K !
          -. Muy/Mry    =   0.192  --->  O.K !
          -. Muz/Mrz    =   0.192  --->  O.K !
          -. Mu/Mr      =   0.192  --->  O.K !
          -. Ratio      =   0.192  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1938.48 kN.
          -. Vuz    =        323.88 kN.
          -. Muy    =       -892.55 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.26

          -. Vuy    =        113.64 kN.
          -. Muz    =       -241.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.17
```

( ). Compute shear strength of concrete.
-. Vuz = 323.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1471.60 kN.
-. phiVcz = phi * Vcz = 1324.44 kN.

-. Vuy = 113.64 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1433.22 kN.
-. phiVcy = phi * Vcy = 1289.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2232.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5676.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2232.89 kN.
-. phiVsz = phi*Vsz = 2009.60 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2216.78 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5715.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2216.78 kN.
-. phiVsy = phi*Vsy = 1995.10 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 343.243 kN.
-. Vr = 3285.000 kN.
-. Ratio = Vu / Vr = 0.104 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 381.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 381.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111122,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1955.16      -730.65      -581.50      -186.96      -139.81
           ------------------------------------------------------------------------------
            DL+LL+Others     1955.16      -730.65      -581.50      -186.96      -139.81
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      581.50 kN-m.
           -. End Moments (My2) =      730.65 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -730.65 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -730.65 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      139.81 kN-m.
          -. End Moments (Mz2) =      186.96 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -186.96 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -186.96 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12077.843 kN.
          -. Mry        =      4488.458 kN-m.
          -. Mrz        =      1148.426 kN-m.
          -. Mr         =      4633.048 kN-m.
          -. Pu/Pr      =   0.162  --->  O.K !
          -. Muy/Mry    =   0.163  --->  O.K !
          -. Muz/Mrz    =   0.163  --->  O.K !
          -. Mu/Mr      =   0.163  --->  O.K !
          -. Ratio      =   0.163  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1955.16 kN.
          -. Vuz    =        298.34 kN.
          -. Muy    =       -730.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.36

          -. Vuy    =         99.07 kN.
          -. Muz    =       -186.96 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.27
```

( ). Compute shear strength of concrete.
-. Vuz = 298.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1516.15 kN.
-. phiVcz = phi * Vcz = 1364.54 kN.

-. Vuy = 99.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1479.07 kN.
-. phiVcy = phi * Vcy = 1331.17 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2250.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5632.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2250.77 kN.
-. phiVsz = phi*Vsz = 2025.69 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2235.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5669.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2235.95 kN.
-. phiVsy = phi*Vsy = 2012.35 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 314.359 kN.
-. Vr = 3343.521 kN.
-. Ratio = Vu / Vr = 0.094 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 349.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 349.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0001 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111123,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1971.83      -581.50      -447.68      -139.81      -100.36
           ---------------------------------------------------------------------------
            DL+LL+Others     1971.83      -581.50      -447.68      -139.81      -100.36
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      447.68 kN-m.
           -. End Moments (My2) =      581.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -581.50 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -581.50 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      100.36 kN-m.
          -. End Moments (Mz2) =      139.81 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -139.81 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -139.81 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14339.510 kN.
          -. Mry        =      4253.404 kN-m.
          -. Mrz        =      1021.088 kN-m.
          -. Mr         =      4374.250 kN-m.
          -. Pu/Pr      =   0.138  --->  O.K !
          -. Muy/Mry    =   0.137  --->  O.K !
          -. Muz/Mrz    =   0.137  --->  O.K !
          -. Mu/Mr      =   0.138  --->  O.K !
          -. Ratio      =   0.138  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1971.83 kN.
          -. Vuz    =        267.67 kN.
          -. Muy    =       -581.50 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.82 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.45

          -. Vuy    =         84.34 kN.
          -. Muz    =       -139.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.97 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.38
```

( ). Compute shear strength of concrete.
-. Vuz = 267.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1560.85 kN.
-. phiVcz = phi * Vcz = 1404.77 kN.

-. Vuy = 84.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1525.23 kN.
-. phiVcy = phi * Vcy = 1372.71 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2267.87 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5587.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2267.87 kN.
-. phiVsz = phi*Vsz = 2041.08 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2254.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5623.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2254.31 kN.
-. phiVsy = phi*Vsy = 2028.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 280.644 kN.
-. Vr = 3401.586 kN.
-. Ratio = Vu / Vr = 0.083 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 311.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 311.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111124,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1988.51      -447.68      -330.84      -100.36       -68.66
           ------------------------------------------------------------------------------
            DL+LL+Others     1988.51      -447.68      -330.84      -100.36       -68.66
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      330.84 kN-m.
           -. End Moments (My2) =      447.68 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -447.68 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -447.68 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       68.66 kN-m.
          -. End Moments (Mz2) =      100.36 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -100.36 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -100.36 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17162.755 kN.
          -. Mry        =      3867.785 kN-m.
          -. Mrz        =       863.473 kN-m.
          -. Mr         =      3962.997 kN-m.
          -. Pu/Pr      =   0.116  --->  O.K !
          -. Muy/Mry    =   0.116  --->  O.K !
          -. Muz/Mrz    =   0.116  --->  O.K !
          -. Mu/Mr      =   0.116  --->  O.K !
          -. Ratio      =   0.116  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1988.51 kN.
          -. Vuz    =        233.72 kN.
          -. Muy    =       -447.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.55

          -. Vuy    =         69.92 kN.
          -. Muz    =       -100.36 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.48
```

( ). Compute shear strength of concrete.
-. Vuz = 233.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1604.36 kN.
-. phiVcz = phi * Vcz = 1443.93 kN.

-. Vuy = 69.92 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1570.32 kN.
-. phiVcy = phi * Vcy = 1413.28 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2283.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5544.12 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2283.77 kN.
-. phiVsz = phi*Vsz = 2055.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2271.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5578.17 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2271.39 kN.
-. phiVsy = phi*Vsy = 2044.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 243.957 kN.
-. Vr = 3457.531 kN.
-. Ratio = Vu / Vr = 0.071 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 271.06 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 271.06 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111125,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2005.18      -330.84      -231.81       -68.66       -44.55
           ------------------------------------------------------------------------------
            DL+LL+Others     2005.18      -330.84      -231.81       -68.66       -44.55
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      231.81 kN-m.
           -. End Moments (My2) =      330.84 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -330.84 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -330.84 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       44.55 kN-m.
          -. End Moments (Mz2) =       68.66 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -68.66 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -68.66 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     20097.394 kN.
          -. Mry        =      3314.219 kN-m.
          -. Mrz        =       685.075 kN-m.
          -. Mr         =      3384.284 kN-m.
          -. Pu/Pr      =   0.100  --->  O.K !
          -. Muy/Mry    =   0.100  --->  O.K !
          -. Muz/Mrz    =   0.100  --->  O.K !
          -. Mu/Mr      =   0.100  --->  O.K !
          -. Ratio      =   0.100  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2005.18 kN.
          -. Vuz    =        198.11 kN.
          -. Muy    =       -330.84 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =         56.19 kN.
          -. Muz    =        -68.66 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 198.11 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1645.41 kN.
-. phiVcz = phi * Vcz = 1480.87 kN.

-. Vuy = 56.19 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1612.98 kN.
-. phiVcy = phi * Vcy = 1451.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2298.14 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5503.08 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2298.14 kN.
-. phiVsz = phi*Vsz = 2068.32 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5535.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.83 kN.
-. phiVsy = phi*Vsy = 2058.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 205.926 kN.
-. Vr = 3509.831 kN.
-. Ratio = Vu / Vr = 0.059 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 228.81 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 228.81 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111126,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2347.83       -73.14       -49.11        -8.55        -4.07
           ------------------------------------------------------------------------------
            DL+LL+Others     2347.83       -73.14       -49.11        -8.55        -4.07
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       49.11 kN-m.
           -. End Moments (My2) =       73.14 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -49.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -49.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.07 kN-m.
          -. End Moments (Mz2) =        8.55 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.07 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.07 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       510.463 kN-m.
          -. Mrz        =        43.044 kN-m.
          -. Mr         =       512.274 kN-m.
          -. Pu/Pr      =   0.096  --->  O.K !
          -. Muy/Mry    =   0.096  --->  O.K !
          -. Muz/Mrz    =   0.095  --->  O.K !
          -. Mu/Mr      =   0.096  --->  O.K !
          -. Ratio      =   0.096  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2021.86 kN.
          -. Vuz    =        162.20 kN.
          -. Muy    =       -231.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.35 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.72

          -. Vuy    =         43.42 kN.
          -. Muz    =        -44.55 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.66
```

( ). Compute shear strength of concrete.
-. Vuz = 162.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1682.85 kN.
-. phiVcz = phi * Vcz = 1514.57 kN.

-. Vuy = 43.42 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1652.02 kN.
-. phiVcy = phi * Vcy = 1486.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2310.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5465.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2310.74 kN.
-. phiVsz = phi*Vsz = 2079.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2300.40 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5496.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2300.40 kN.
-. phiVsy = phi*Vsy = 2070.36 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 167.909 kN.
-. Vr = 3557.175 kN.
-. Ratio = Vu / Vr = 0.047 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 186.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 186.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111127,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2364.48       -49.11       -30.11        -4.07        -1.79
           ------------------------------------------------------------------------------
            DL+LL+Others     2364.48       -49.11       -30.11        -4.07        -1.79
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       30.11 kN-m.
           -. End Moments (My2) =       49.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -30.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -30.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.79 kN-m.
          -. End Moments (Mz2) =        4.07 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.79 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.79 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       310.812 kN-m.
          -. Mrz        =        18.680 kN-m.
          -. Mr         =       311.373 kN-m.
          -. Pu/Pr      =   0.097  --->  O.K !
          -. Muy/Mry    =   0.097  --->  O.K !
          -. Muz/Mrz    =   0.096  --->  O.K !
          -. Mu/Mr      =   0.097  --->  O.K !
          -. Ratio      =   0.097  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2038.53 kN.
          -. Vuz    =        127.06 kN.
          -. Muy    =       -150.75 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.80

          -. Vuy    =         31.84 kN.
          -. Muz    =        -27.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.33 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.73
```

( ). Compute shear strength of concrete.
-. Vuz = 127.06 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1715.78 kN.
-. phiVcz = phi * Vcz = 1544.21 kN.

-. Vuy = 31.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1686.44 kN.
-. phiVcy = phi * Vcy = 1517.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2321.46 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5432.70 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2321.46 kN.
-. phiVsz = phi*Vsz = 2089.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2311.93 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5462.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2311.93 kN.
-. phiVsy = phi*Vsy = 2080.74 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 130.990 kN.
-. Vr = 3598.532 kN.
-. Ratio = Vu / Vr = 0.036 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 145.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 145.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0025 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111128,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2381.14       -30.11       -15.97        -1.79        -1.39
           ------------------------------------------------------------------------------
            DL+LL+Others     2381.14       -30.11       -15.97        -1.79        -1.39
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       15.97 kN-m.
           -. End Moments (My2) =       30.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -15.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -15.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.39 kN-m.
          -. End Moments (Mz2) =        1.79 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.39 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.39 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       163.655 kN-m.
          -. Mrz        =        14.035 kN-m.
          -. Mr         =       164.256 kN-m.
          -. Pu/Pr      =   0.098  --->  O.K !
          -. Muy/Mry    =   0.098  --->  O.K !
          -. Muz/Mrz    =   0.099  --->  O.K !
          -. Mu/Mr      =   0.099  --->  O.K !
          -. Ratio      =   0.099  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2071.86 kN.
          -. Vuz    =         93.53 kN.
          -. Muy    =        -40.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.14 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.86

          -. Vuy    =         21.60 kN.
          -. Muz    =        -20.97 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.80
```

( ). Compute shear strength of concrete.
-. Vuz = 93.53 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1743.12 kN.
-. phiVcz = phi * Vcz = 1568.80 kN.

-. Vuy = 21.60 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1715.08 kN.
-. phiVcy = phi * Vcy = 1543.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2330.09 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5405.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2330.09 kN.
-. phiVsz = phi*Vsz = 2097.09 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2321.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5433.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2321.23 kN.
-. phiVsy = phi*Vsy = 2089.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 95.996 kN.
-. Vr = 3632.676 kN.
-. Ratio = Vu / Vr = 0.026 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 106.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 106.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111129,  LCB = 148-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2381.14       -15.97       -13.11        -1.39        -3.77
           ------------------------------------------------------------------------------
            DL+LL+Others     2381.14       -15.97       -13.11        -1.39        -3.77
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.11 kN-m.
           -. End Moments (My2) =       15.97 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -15.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -15.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.39 kN-m.
          -. End Moments (Mz2) =        3.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.39 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.39 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       163.655 kN-m.
          -. Mrz        =        14.035 kN-m.
          -. Mr         =       164.256 kN-m.
          -. Pu/Pr      =   0.098  --->  O.K !
          -. Muy/Mry    =   0.098  --->  O.K !
          -. Muz/Mrz    =   0.099  --->  O.K !
          -. Mu/Mr      =   0.099  --->  O.K !
          -. Ratio      =   0.099  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2088.53 kN.
          -. Vuz    =         66.77 kN.
          -. Muy    =         -9.20 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =         14.13 kN.
          -. Muz    =        -26.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 66.77 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1756.35 kN.
-. phiVcz = phi * Vcz = 1580.71 kN.

-. Vuy = 14.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.96 kN.
-. phiVcy = phi * Vcy = 1556.07 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2334.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5392.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2334.20 kN.
-. phiVsz = phi*Vsz = 2100.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5419.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.65 kN.
-. phiVsy = phi*Vsy = 2093.08 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 68.249 kN.
-. Vr = 3649.151 kN.
-. Ratio = Vu / Vr = 0.019 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 75.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 75.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111130,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2414.45       -13.11       -12.99        -3.77        -5.67
           ------------------------------------------------------------------------------
            DL+LL+Others     2414.45       -13.11       -12.99        -3.77        -5.67
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       12.99 kN-m.
           -. End Moments (My2) =       13.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -12.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -12.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.77 kN-m.
          -. End Moments (Mz2) =        5.67 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -5.67 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -5.67 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       131.296 kN-m.
          -. Mrz        =        57.452 kN-m.
          -. Mr         =       143.316 kN-m.
          -. Pu/Pr      =   0.099  --->  O.K !
          -. Muy/Mry    =   0.099  --->  O.K !
          -. Muz/Mrz    =   0.099  --->  O.K !
          -. Mu/Mr      =   0.099  --->  O.K !
          -. Ratio      =   0.099  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2105.20 kN.
          -. Vuz    =         50.76 kN.
          -. Muy    =        -22.96 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =         10.08 kN.
          -. Muz    =        -30.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 50.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1763.35 kN.
-. phiVcz = phi * Vcz = 1587.01 kN.

-. Vuy = 10.08 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1736.31 kN.
-. phiVcy = phi * Vcy = 1562.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2336.35 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5385.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2336.35 kN.
-. phiVsz = phi*Vsz = 2102.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.97 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5412.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.97 kN.
-. phiVsy = phi*Vsy = 2095.17 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 51.755 kN.
-. Vr = 3657.848 kN.
-. Ratio = Vu / Vr = 0.014 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 57.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 57.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111131,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2431.11       -12.99       -13.83        -5.67        -7.02
           ------------------------------------------------------------------------------
            DL+LL+Others     2431.11       -12.99       -13.83        -5.67        -7.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       12.99 kN-m.
           -. End Moments (My2) =       13.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        5.67 kN-m.
          -. End Moments (Mz2) =        7.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -7.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -7.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       138.805 kN-m.
          -. Mrz        =        70.445 kN-m.
          -. Mr         =       155.658 kN-m.
          -. Pu/Pr      =   0.100  --->  O.K !
          -. Muy/Mry    =   0.100  --->  O.K !
          -. Muz/Mrz    =   0.100  --->  O.K !
          -. Mu/Mr      =   0.100  --->  O.K !
          -. Ratio      =   0.100  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2121.86 kN.
          -. Vuz    =         36.61 kN.
          -. Muy    =        -38.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =          6.86 kN.
          -. Muz    =        -32.29 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 36.61 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1763.18 kN.
-. phiVcz = phi * Vcz = 1586.86 kN.

-. Vuy = 6.86 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1736.13 kN.
-. phiVcy = phi * Vcy = 1562.52 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2336.29 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5385.31 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2336.29 kN.
-. phiVsz = phi*Vsz = 2102.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.91 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5412.36 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.91 kN.
-. phiVsy = phi*Vsy = 2095.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 37.250 kN.
-. Vr = 3657.634 kN.
-. Ratio = Vu / Vr = 0.010 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 41.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 41.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111132,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2447.76       -13.83       -14.29        -7.02        -8.02
           ------------------------------------------------------------------------------
            DL+LL+Others     2447.76       -13.83       -14.29        -7.02        -8.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.83 kN-m.
           -. End Moments (My2) =       14.29 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -14.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -14.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        7.02 kN-m.
          -. End Moments (Mz2) =        8.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       142.457 kN-m.
          -. Mrz        =        79.991 kN-m.
          -. Mr         =       163.379 kN-m.
          -. Pu/Pr      =   0.100  --->  O.K !
          -. Muy/Mry    =   0.100  --->  O.K !
          -. Muz/Mrz    =   0.100  --->  O.K !
          -. Mu/Mr      =   0.100  --->  O.K !
          -. Ratio      =   0.100  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2138.53 kN.
          -. Vuz    =         24.33 kN.
          -. Muy    =        -49.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =          4.44 kN.
          -. Muz    =        -33.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 24.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1761.38 kN.
-. phiVcz = phi * Vcz = 1585.24 kN.

-. Vuy = 4.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1734.25 kN.
-. phiVcy = phi * Vcy = 1560.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2335.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5387.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2335.74 kN.
-. phiVsz = phi*Vsz = 2102.17 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5414.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.32 kN.
-. phiVsy = phi*Vsy = 2094.58 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 24.732 kN.
-. Vr = 3655.406 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 27.48 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 27.48 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111133,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2464.42       -14.29       -14.22        -8.02        -8.58
           ------------------------------------------------------------------------------
            DL+LL+Others     2464.42       -14.29       -14.22        -8.02        -8.58
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       14.22 kN-m.
           -. End Moments (My2) =       14.29 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -14.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -14.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.02 kN-m.
          -. End Moments (Mz2) =        8.58 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.58 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.58 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       140.770 kN-m.
          -. Mrz        =        84.928 kN-m.
          -. Mr         =       164.405 kN-m.
          -. Pu/Pr      =   0.101  --->  O.K !
          -. Muy/Mry    =   0.101  --->  O.K !
          -. Muz/Mrz    =   0.101  --->  O.K !
          -. Mu/Mr      =   0.101  --->  O.K !
          -. Ratio      =   0.101  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2155.20 kN.
          -. Vuz    =         13.88 kN.
          -. Muy    =        -55.53 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =          2.94 kN.
          -. Muz    =        -32.54 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 13.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1760.45 kN.
-. phiVcz = phi * Vcz = 1584.41 kN.

-. Vuy = 2.94 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1733.27 kN.
-. phiVcy = phi * Vcy = 1559.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2335.46 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5388.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2335.46 kN.
-. phiVsz = phi*Vsz = 2101.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.01 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5415.22 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.01 kN.
-. phiVsy = phi*Vsy = 2094.31 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 14.187 kN.
-. Vr = 3654.253 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 15.76 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 15.76 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111134,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2481.07       -14.22       -13.82        -8.58        -9.03
           ------------------------------------------------------------------------------
            DL+LL+Others     2481.07       -14.22       -13.82        -8.58        -9.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.82 kN-m.
           -. End Moments (My2) =       14.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.58 kN-m.
          -. End Moments (Mz2) =        9.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -9.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -9.03 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       135.838 kN-m.
          -. Mrz        =        88.994 kN-m.
          -. Mr         =       162.394 kN-m.
          -. Pu/Pr      =   0.102  --->  O.K !
          -. Muy/Mry    =   0.102  --->  O.K !
          -. Muz/Mrz    =   0.101  --->  O.K !
          -. Mu/Mr      =   0.102  --->  O.K !
          -. Ratio      =   0.102  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1000.51 kN.
          -. Vuz    =          4.89 kN.
          -. Muy    =         41.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.26

          -. Vuy    =          7.89 kN.
          -. Muz    =         54.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.26
```

( ). Compute shear strength of concrete.
-. Vuz = 4.89 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1924.63 kN.
-. phiVcz = phi * Vcz = 1732.17 kN.

-. Vuy = 7.89 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1924.63 kN.
-. phiVcy = phi * Vcy = 1732.17 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2382.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5223.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2382.24 kN.
-. phiVsz = phi*Vsz = 2144.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2382.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5223.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2382.24 kN.
-. phiVsy = phi*Vsy = 2144.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 9.285 kN.
-. Vr = 3876.183 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111135,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2497.73       -13.82       -13.39        -9.03        -9.21
           ------------------------------------------------------------------------------
            DL+LL+Others     2497.73       -13.82       -13.39        -9.03        -9.21
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.39 kN-m.
           -. End Moments (My2) =       13.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        9.03 kN-m.
          -. End Moments (Mz2) =        9.21 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -9.21 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -9.21 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       130.848 kN-m.
          -. Mrz        =        89.847 kN-m.
          -. Mr         =       158.725 kN-m.
          -. Pu/Pr      =   0.102  --->  O.K !
          -. Muy/Mry    =   0.102  --->  O.K !
          -. Muz/Mrz    =   0.102  --->  O.K !
          -. Mu/Mr      =   0.102  --->  O.K !
          -. Ratio      =   0.102  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1012.50 kN.
          -. Vuz    =          1.59 kN.
          -. Muy    =         41.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.26

          -. Vuy    =         10.30 kN.
          -. Muz    =         49.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.26
```

( ). Compute shear strength of concrete.
-. Vuz = 1.59 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1923.65 kN.
-. phiVcz = phi * Vcz = 1731.29 kN.

-. Vuy = 10.30 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1923.65 kN.
-. phiVcy = phi * Vcy = 1731.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2381.98 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5224.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2381.98 kN.
-. phiVsz = phi*Vsz = 2143.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2381.98 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5224.84 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2381.98 kN.
-. phiVsy = phi*Vsy = 2143.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 10.422 kN.
-. Vr = 3875.064 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 11.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 11.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111136,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2514.38       -13.39       -12.44        -9.21        -8.92
           ------------------------------------------------------------------------------
            DL+LL+Others     2514.38       -13.39       -12.44        -9.21        -8.92
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       12.44 kN-m.
           -. End Moments (My2) =       13.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -12.44 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -12.44 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.92 kN-m.
          -. End Moments (Mz2) =        9.21 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.92 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.92 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       120.715 kN-m.
          -. Mrz        =        86.541 kN-m.
          -. Mr         =       148.531 kN-m.
          -. Pu/Pr      =   0.103  --->  O.K !
          -. Muy/Mry    =   0.103  --->  O.K !
          -. Muz/Mrz    =   0.103  --->  O.K !
          -. Mu/Mr      =   0.103  --->  O.K !
          -. Ratio      =   0.103  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1012.49 kN.
          -. Vuz    =          4.92 kN.
          -. Muy    =         41.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.26

          -. Vuy    =         11.95 kN.
          -. Muz    =         49.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.60 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.26
```

( ). Compute shear strength of concrete.
-. Vuz = 4.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1922.73 kN.
-. phiVcz = phi * Vcz = 1730.46 kN.

-. Vuy = 11.95 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1922.73 kN.
-. phiVcy = phi * Vcy = 1730.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2381.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5225.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2381.73 kN.
-. phiVsz = phi*Vsz = 2143.56 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2381.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5225.75 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2381.73 kN.
-. phiVsy = phi*Vsy = 2143.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 12.922 kN.
-. Vr = 3874.020 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 14.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 14.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111137,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2531.04       -12.44       -11.03        -8.92        -8.20
           ---------------------------------------------------------------------------
            DL+LL+Others     2531.04       -12.44       -11.03        -8.92        -8.20
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       11.03 kN-m.
           -. End Moments (My2) =       12.44 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -11.03 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -11.03 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.20 kN-m.
          -. End Moments (Mz2) =        8.92 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.20 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.20 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       106.347 kN-m.
          -. Mrz        =        79.055 kN-m.
          -. Mr         =       132.512 kN-m.
          -. Pu/Pr      =   0.104  --->  O.K !
          -. Muy/Mry    =   0.104  --->  O.K !
          -. Muz/Mrz    =   0.104  --->  O.K !
          -. Mu/Mr      =   0.104  --->  O.K !
          -. Ratio      =   0.104  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2088.02 kN.
          -. Vuz    =          8.07 kN.
          -. Muy    =        -38.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.92

          -. Vuy    =         12.71 kN.
          -. Muz    =        -46.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.86
```

( ). Compute shear strength of concrete.
-. Vuz = 8.07 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1771.12 kN.
-. phiVcz = phi * Vcz = 1594.01 kN.

-. Vuy = 12.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1744.48 kN.
-. phiVcy = phi * Vcy = 1570.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2338.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5377.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2338.72 kN.
-. phiVsz = phi*Vsz = 2104.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2330.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5404.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2330.52 kN.
-. phiVsy = phi*Vsy = 2097.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.057 kN.
-. Vr = 3667.501 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 16.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 16.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111138,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2547.70       -11.03        -9.37        -8.20        -7.20
           ------------------------------------------------------------------------------
            DL+LL+Others     2547.70       -11.03        -9.37        -8.20        -7.20
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        9.37 kN-m.
           -. End Moments (My2) =       11.03 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -9.37 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -9.37 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        7.20 kN-m.
          -. End Moments (Mz2) =        8.20 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -7.20 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -7.20 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        89.737 kN-m.
          -. Mrz        =        69.004 kN-m.
          -. Mr         =       113.200 kN-m.
          -. Pu/Pr      =   0.104  --->  O.K !
          -. Muy/Mry    =   0.104  --->  O.K !
          -. Muz/Mrz    =   0.104  --->  O.K !
          -. Mu/Mr      =   0.104  --->  O.K !
          -. Ratio      =   0.104  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2104.68 kN.
          -. Vuz    =          9.87 kN.
          -. Muy    =        -34.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.92

          -. Vuy    =         13.66 kN.
          -. Muz    =        -40.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.86
```

( ). Compute shear strength of concrete.
-. Vuz = 9.87 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1770.67 kN.
-. phiVcz = phi * Vcz = 1593.60 kN.

-. Vuy = 13.66 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1744.00 kN.
-. phiVcy = phi * Vcy = 1569.60 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2338.58 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5377.82 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2338.58 kN.
-. phiVsz = phi*Vsz = 2104.72 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2330.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5404.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2330.37 kN.
-. phiVsy = phi*Vsy = 2097.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 16.851 kN.
-. Vr = 3666.933 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 18.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 18.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111139,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2564.35        -9.37        -7.62        -7.20        -6.06
           ------------------------------------------------------------------------------
            DL+LL+Others     2564.35        -9.37        -7.62        -7.20        -6.06
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.62 kN-m.
           -. End Moments (My2) =        9.37 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        6.06 kN-m.
          -. End Moments (Mz2) =        7.20 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -6.06 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -6.06 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        72.624 kN-m.
          -. Mrz        =        57.553 kN-m.
          -. Mr         =        92.664 kN-m.
          -. Pu/Pr      =   0.105  --->  O.K !
          -. Muy/Mry    =   0.105  --->  O.K !
          -. Muz/Mrz    =   0.105  --->  O.K !
          -. Mu/Mr      =   0.105  --->  O.K !
          -. Ratio      =   0.105  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2121.34 kN.
          -. Vuz    =         10.56 kN.
          -. Muy    =        -29.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.92

          -. Vuy    =         13.87 kN.
          -. Muz    =        -33.79 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.86
```

( ). Compute shear strength of concrete.
-. Vuz = 10.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1770.88 kN.
-. phiVcz = phi * Vcz = 1593.79 kN.

-. Vuy = 13.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1744.23 kN.
-. phiVcy = phi * Vcy = 1569.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2338.64 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5377.60 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2338.64 kN.
-. phiVsz = phi*Vsz = 2104.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2330.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5404.26 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2330.44 kN.
-. phiVsy = phi*Vsy = 2097.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 17.434 kN.
-. Vr = 3667.201 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 19.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 19.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111140,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2581.01        -7.62        -5.81        -6.06        -4.77
           ------------------------------------------------------------------------------
            DL+LL+Others     2581.01        -7.62        -5.81        -6.06        -4.77
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        5.81 kN-m.
           -. End Moments (My2) =        7.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -5.81 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -5.81 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.77 kN-m.
          -. End Moments (Mz2) =        6.06 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.77 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        54.961 kN-m.
          -. Mrz        =        45.046 kN-m.
          -. Mr         =        71.062 kN-m.
          -. Pu/Pr      =   0.106  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.106  --->  O.K !
          -. Mu/Mr      =   0.106  --->  O.K !
          -. Ratio      =   0.106  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2138.00 kN.
          -. Vuz    =         11.12 kN.
          -. Muy    =        -23.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.92

          -. Vuy    =         13.70 kN.
          -. Muz    =        -26.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.86
```

( ). Compute shear strength of concrete.
-. Vuz = 11.12 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1771.31 kN.
-. phiVcz = phi * Vcz = 1594.18 kN.

-. Vuy = 13.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1744.68 kN.
-. phiVcy = phi * Vcy = 1570.21 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2338.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5377.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2338.77 kN.
-. phiVsz = phi*Vsz = 2104.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2330.58 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5403.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2330.58 kN.
-. phiVsy = phi*Vsy = 2097.52 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 17.644 kN.
-. Vr = 3667.733 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 19.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 19.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111141,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2597.66        -5.81        -4.05        -4.77        -3.41
           ------------------------------------------------------------------------------
            DL+LL+Others     2597.66        -5.81        -4.05        -4.77        -3.41
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.05 kN-m.
           -. End Moments (My2) =        5.81 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.41 kN-m.
          -. End Moments (Mz2) =        4.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.41 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.41 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        38.021 kN-m.
          -. Mrz        =        32.032 kN-m.
          -. Mr         =        49.716 kN-m.
          -. Pu/Pr      =   0.106  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.106  --->  O.K !
          -. Mu/Mr      =   0.106  --->  O.K !
          -. Ratio      =   0.106  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2154.65 kN.
          -. Vuz    =         10.99 kN.
          -. Muy    =        -18.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.04 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.92

          -. Vuy    =         12.70 kN.
          -. Muz    =        -20.06 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.86
```

( ). Compute shear strength of concrete.
-. Vuz = 10.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1772.09 kN.
-. phiVcz = phi * Vcz = 1594.88 kN.

-. Vuy = 12.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1745.50 kN.
-. phiVcy = phi * Vcy = 1570.95 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2339.01 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5376.40 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2339.01 kN.
-. phiVsz = phi*Vsz = 2105.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2330.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5402.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2330.84 kN.
-. phiVsy = phi*Vsy = 2097.75 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 16.792 kN.
-. Vr = 3668.699 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 18.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 18.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111142,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2614.32        -4.05        -2.46        -3.41        -2.13
           ------------------------------------------------------------------------------
            DL+LL+Others     2614.32        -4.05        -2.46        -3.41        -2.13
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.46 kN-m.
           -. End Moments (My2) =        4.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.46 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.46 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        2.13 kN-m.
          -. End Moments (Mz2) =        3.41 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -2.13 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -2.13 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        23.011 kN-m.
          -. Mrz        =        19.836 kN-m.
          -. Mr         =        30.381 kN-m.
          -. Pu/Pr      =   0.107  --->  O.K !
          -. Muy/Mry    =   0.107  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2187.97 kN.
          -. Vuz    =          9.98 kN.
          -. Muy    =         -7.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.04 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.92

          -. Vuy    =         11.00 kN.
          -. Muz    =         -8.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.86
```

( ). Compute shear strength of concrete.
-. Vuz = 9.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1772.64 kN.
-. phiVcz = phi * Vcz = 1595.37 kN.

-. Vuy = 11.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1746.07 kN.
-. phiVcy = phi * Vcy = 1571.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2339.18 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5375.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2339.18 kN.
-. phiVsz = phi*Vsz = 2105.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2331.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5402.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2331.02 kN.
-. phiVsy = phi*Vsy = 2097.91 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 14.851 kN.
-. Vr = 3669.378 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 16.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 16.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111143,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2630.98        -2.46        -1.19        -2.13        -1.04
           ------------------------------------------------------------------------------
            DL+LL+Others     2630.98        -2.46        -1.19        -2.13        -1.04
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.19 kN-m.
           -. End Moments (My2) =        2.46 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.19 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.19 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.04 kN-m.
          -. End Moments (Mz2) =        2.13 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.04 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.04 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        10.995 kN-m.
          -. Mrz        =         9.675 kN-m.
          -. Mr         =        14.645 kN-m.
          -. Pu/Pr      =   0.108  --->  O.K !
          -. Muy/Mry    =   0.108  --->  O.K !
          -. Muz/Mrz    =   0.108  --->  O.K !
          -. Mu/Mr      =   0.108  --->  O.K !
          -. Ratio      =   0.108  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2321.82 kN.
          -. Vuz    =         10.85 kN.
          -. Muy    =         -5.03 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          4.84 kN.
          -. Muz    =         -2.19 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.82
```

( ). Compute shear strength of concrete.
-. Vuz = 10.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1755.24 kN.
-. phiVcz = phi * Vcz = 1579.72 kN.

-. Vuy = 4.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1727.80 kN.
-. phiVcy = phi * Vcy = 1555.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2333.86 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5393.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2333.86 kN.
-. phiVsz = phi*Vsz = 2100.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.28 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5420.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.28 kN.
-. phiVsy = phi*Vsy = 2092.75 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 11.882 kN.
-. Vr = 3647.775 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 13.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 13.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111144,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2647.63        -1.19        -0.33        -1.04        -0.29
           ------------------------------------------------------------------------------
            DL+LL+Others     2647.63        -1.19        -0.33        -1.04        -0.29
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.33 kN-m.
           -. End Moments (My2) =        1.19 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.33 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.33 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.29 kN-m.
          -. End Moments (Mz2) =        1.04 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.29 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         2.998 kN-m.
          -. Mrz        =         2.695 kN-m.
          -. Mr         =         4.031 kN-m.
          -. Pu/Pr      =   0.108  --->  O.K !
          -. Muy/Mry    =   0.109  --->  O.K !
          -. Muz/Mrz    =   0.108  --->  O.K !
          -. Mu/Mr      =   0.109  --->  O.K !
          -. Ratio      =   0.109  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2338.48 kN.
          -. Vuz    =          7.30 kN.
          -. Muy    =         -1.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.88

          -. Vuy    =          3.20 kN.
          -. Muz    =         -0.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.82
```

( ). Compute shear strength of concrete.
-. Vuz = 7.30 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1755.10 kN.
-. phiVcz = phi * Vcz = 1579.59 kN.

-. Vuy = 3.20 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1727.65 kN.
-. phiVcy = phi * Vcy = 1554.89 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2333.81 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5393.38 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2333.81 kN.
-. phiVsz = phi*Vsz = 2100.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5420.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.24 kN.
-. phiVsy = phi*Vsy = 2092.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 7.968 kN.
-. Vr = 3647.599 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 8.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 8.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111145,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2664.29        -0.33         0.00        -0.29         0.00
           ---------------------------------------------------------------------------
            DL+LL+Others     2664.29        -0.33         0.00        -0.29         0.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.33 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y             =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z             =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.109  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.109  --->  O.K !
          -. Ratio      =   0.109  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2355.14 kN.
          -. Vuz    =          2.76 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.83

          -. Vuy    =          1.19 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 2.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1728.12 kN.
-. phiVcz = phi * Vcz = 1555.31 kN.

-. Vuy = 1.19 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.12 kN.
-. phiVcy = phi * Vcy = 1555.31 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2325.39 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5420.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2325.39 kN.
-. phiVsz = phi*Vsz = 2092.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5420.36 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.39 kN.
-. phiVsy = phi*Vsy = 2092.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 3.007 kN.
-. Vr = 3648.159 kN.
-. Ratio = Vu / Vr =8.242e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 3.34 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 3.34 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111202,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            638.78       334.08       287.45      1370.98      1532.24
           ---------------------------------------------------------------------------
            DL+LL+Others      638.78       334.08       287.45      1370.98      1532.24
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      287.45 kN-m.
           -. End Moments (My2) =      334.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      287.45 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      287.45 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1370.98 kN-m.
          -. End Moments (Mz2) =     1532.24 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1532.24 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1532.24 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2123.670 kN.
          -. Mry        =       948.245 kN-m.
          -. Mrz        =      5055.090 kN-m.
          -. Mr         =      5143.258 kN-m.
          -. Pu/Pr      =   0.301  --->  O.K !
          -. Muy/Mry    =   0.303  --->  O.K !
          -. Muz/Mrz    =   0.303  --->  O.K !
          -. Mu/Mr      =   0.303  --->  O.K !
          -. Ratio      =   0.303  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1639.49 kN.
          -. Vuz    =        976.09 kN.
          -. Muy    =       -575.09 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.74 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.02

          -. Vuy    =        211.49 kN.
          -. Muz    =       -793.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.97 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.93
```

( ). Compute shear strength of concrete.
-. Vuz = 976.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1366.53 kN.
-. phiVcz = phi * Vcz = 1229.88 kN.

-. Vuy = 211.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1325.68 kN.
-. phiVcy = phi * Vcy = 1193.11 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2187.09 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5781.95 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2187.09 kN.
-. phiVsz = phi*Vsz = 1968.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2167.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5822.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2167.74 kN.
-. phiVsy = phi*Vsy = 1950.97 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 998.736 kN.
-. Vr = 3144.079 kN.
-. Ratio = Vu / Vr = 0.318 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1109.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1109.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111203,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            650.76       287.45       351.33      1532.24      1656.85
           ------------------------------------------------------------------------------
            DL+LL+Others      650.76       287.45       351.33      1532.24      1656.85
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      287.45 kN-m.
           -. End Moments (My2) =      351.33 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      351.33 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      351.33 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1532.24 kN-m.
          -. End Moments (Mz2) =     1656.85 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1656.85 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1656.85 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1968.861 kN.
          -. Mry        =      1061.496 kN-m.
          -. Mrz        =      5020.223 kN-m.
          -. Mr         =      5131.219 kN-m.
          -. Pu/Pr      =   0.331  --->  O.K !
          -. Muy/Mry    =   0.331  --->  O.K !
          -. Muz/Mrz    =   0.330  --->  O.K !
          -. Mu/Mr      =   0.331  --->  O.K !
          -. Ratio      =   0.331  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1656.18 kN.
          -. Vuz    =        849.54 kN.
          -. Muy    =       -884.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        172.60 kN.
          -. Muz    =       -883.28 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86
```

( ). Compute shear strength of concrete.
-. Vuz = 849.54 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1334.97 kN.
-. phiVcz = phi * Vcz = 1201.47 kN.

-. Vuy = 172.60 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1293.53 kN.
-. phiVcy = phi * Vcy = 1164.18 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2172.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5813.52 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2172.23 kN.
-. phiVsz = phi*Vsz = 1955.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2151.85 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5854.95 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2151.85 kN.
-. phiVsy = phi*Vsy = 1936.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 866.894 kN.
-. Vr = 3100.843 kN.
-. Ratio = Vu / Vr = 0.280 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 963.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 963.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111204,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            662.73       351.33       517.29      1656.85      1745.50
           ------------------------------------------------------------------------------
            DL+LL+Others      662.73       351.33       517.29      1656.85      1745.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      351.33 kN-m.
           -. End Moments (My2) =      517.29 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      517.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      517.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1656.85 kN-m.
          -. End Moments (Mz2) =     1745.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1745.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1745.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1858.560 kN.
          -. Mry        =      1450.251 kN-m.
          -. Mrz        =      4909.503 kN-m.
          -. Mr         =      5119.223 kN-m.
          -. Pu/Pr      =   0.357  --->  O.K !
          -. Muy/Mry    =   0.357  --->  O.K !
          -. Muz/Mrz    =   0.356  --->  O.K !
          -. Mu/Mr      =   0.357  --->  O.K !
          -. Ratio      =   0.357  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1672.86 kN.
          -. Vuz    =        723.96 kN.
          -. Muy    =      -1180.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89

          -. Vuy    =        136.87 kN.
          -. Muz    =       -954.61 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.80
```

( ). Compute shear strength of concrete.
-. Vuz = 723.96 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1304.79 kN.
-. phiVcz = phi * Vcz = 1174.31 kN.

-. Vuy = 136.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1262.87 kN.
-. phiVcy = phi * Vcy = 1136.58 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2157.48 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5843.70 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2157.48 kN.
-. phiVsz = phi*Vsz = 1941.73 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2136.10 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5885.62 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2136.10 kN.
-. phiVsy = phi*Vsy = 1922.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 736.790 kN.
-. Vr = 3059.068 kN.
-. Ratio = Vu / Vr = 0.241 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 818.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 818.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111205,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            674.71       517.29       695.30      1745.50      1800.70
           ------------------------------------------------------------------------------
            DL+LL+Others      674.71       517.29       695.30      1745.50      1800.70
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      517.29 kN-m.
           -. End Moments (My2) =      695.30 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      695.30 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      695.30 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1745.50 kN-m.
          -. End Moments (Mz2) =     1800.70 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1800.70 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1800.70 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1803.923 kN.
          -. Mry        =      1853.386 kN-m.
          -. Mrz        =      4772.177 kN-m.
          -. Mr         =      5119.445 kN-m.
          -. Pu/Pr      =   0.374  --->  O.K !
          -. Muy/Mry    =   0.375  --->  O.K !
          -. Muz/Mrz    =   0.377  --->  O.K !
          -. Mu/Mr      =   0.377  --->  O.K !
          -. Ratio      =   0.377  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1689.54 kN.
          -. Vuz    =        600.71 kN.
          -. Muy    =      -1435.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        105.18 kN.
          -. Muz    =      -1007.84 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 600.71 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1281.19 kN.
-. phiVcz = phi * Vcz = 1153.07 kN.

-. Vuy = 105.18 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1238.94 kN.
-. phiVcy = phi * Vcy = 1115.05 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2145.58 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5867.30 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2145.58 kN.
-. phiVsz = phi*Vsz = 1931.02 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5909.55 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.39 kN.
-. phiVsy = phi*Vsy = 1911.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 609.845 kN.
-. Vr = 3026.095 kN.
-. Ratio = Vu / Vr = 0.202 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 677.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 677.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111206,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            686.68       695.30       849.92      1800.70      1823.38
           ---------------------------------------------------------------------------
            DL+LL+Others      686.68       695.30       849.92      1800.70      1823.38
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      695.30 kN-m.
           -. End Moments (My2) =      849.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      849.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      849.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1800.70 kN-m.
          -. End Moments (Mz2) =     1823.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1823.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1823.38 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1743.407 kN.
          -. Mry        =      2161.038 kN-m.
          -. Mrz        =      4635.035 kN-m.
          -. Mr         =      5114.062 kN-m.
          -. Pu/Pr      =   0.394  --->  O.K !
          -. Muy/Mry    =   0.393  --->  O.K !
          -. Muz/Mrz    =   0.393  --->  O.K !
          -. Mu/Mr      =   0.394  --->  O.K !
          -. Ratio      =   0.394  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1706.22 kN.
          -. Vuz    =        481.08 kN.
          -. Muy    =      -1638.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =         78.39 kN.
          -. Muz    =      -1041.96 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 481.08 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1265.77 kN.
-. phiVcz = phi * Vcz = 1139.19 kN.

-. Vuy = 78.39 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1223.33 kN.
-. phiVcy = phi * Vcy = 1100.99 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2137.61 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5882.72 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2137.61 kN.
-. phiVsz = phi*Vsz = 1923.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2114.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5925.16 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2114.89 kN.
-. phiVsy = phi*Vsy = 1903.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 487.427 kN.
-. Vr = 3004.390 kN.
-. Ratio = Vu / Vr = 0.162 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 541.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 541.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0043 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0043 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111207,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            677.76      1596.49      1770.04      1118.34      1078.82
           ------------------------------------------------------------------------------
            DL+LL+Others      677.76      1596.49      1770.04      1118.34      1078.82
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1596.49 kN-m.
           -. End Moments (My2) =     1770.04 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1770.04 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1770.04 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1078.82 kN-m.
          -. End Moments (Mz2) =     1118.34 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1078.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1078.82 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1658.899 kN.
          -. Mry        =      4357.041 kN-m.
          -. Mrz        =      2667.255 kN-m.
          -. Mr         =      5108.626 kN-m.
          -. Pu/Pr      =   0.409  --->  O.K !
          -. Muy/Mry    =   0.406  --->  O.K !
          -. Muz/Mrz    =   0.404  --->  O.K !
          -. Mu/Mr      =   0.409  --->  O.K !
          -. Ratio      =   0.409  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1722.89 kN.
          -. Vuz    =        366.42 kN.
          -. Muy    =      -1791.69 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =         57.15 kN.
          -. Muz    =      -1057.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69
```

( ). Compute shear strength of concrete.
-. Vuz = 366.42 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1258.19 kN.
-. phiVcz = phi * Vcz = 1132.37 kN.

-. Vuy = 57.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1215.66 kN.
-. phiVcy = phi * Vcy = 1094.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2133.64 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5890.30 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2133.64 kN.
-. phiVsz = phi*Vsz = 1920.28 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2110.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5932.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2110.65 kN.
-. phiVsy = phi*Vsy = 1899.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 370.846 kN.
-. Vr = 2993.680 kN.
-. Ratio = Vu / Vr = 0.124 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 412.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 412.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111208,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            689.73      1770.04      1890.92      1078.82      1033.66
           ---------------------------------------------------------------------------
            DL+LL+Others      689.73      1770.04      1890.92      1078.82      1033.66
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1770.04 kN-m.
           -. End Moments (My2) =     1890.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1890.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1890.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1033.66 kN-m.
          -. End Moments (Mz2) =     1078.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1033.66 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1033.66 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1638.830 kN.
          -. Mry        =      4476.975 kN-m.
          -. Mrz        =      2446.686 kN-m.
          -. Mr         =      5101.919 kN-m.
          -. Pu/Pr      =   0.421  --->  O.K !
          -. Muy/Mry    =   0.422  --->  O.K !
          -. Muz/Mrz    =   0.422  --->  O.K !
          -. Mu/Mr      =   0.422  --->  O.K !
          -. Ratio      =   0.422  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1739.57 kN.
          -. Vuz    =        257.96 kN.
          -. Muy    =      -1894.50 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =         43.03 kN.
          -. Muz    =      -1059.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69
```

( ). Compute shear strength of concrete.
-. Vuz = 257.96 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1257.69 kN.
-. phiVcz = phi * Vcz = 1131.92 kN.

-. Vuy = 43.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1215.16 kN.
-. phiVcy = phi * Vcy = 1093.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2133.38 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5890.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2133.38 kN.
-. phiVsz = phi*Vsz = 1920.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2110.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5933.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2110.37 kN.
-. phiVsy = phi*Vsy = 1899.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 261.524 kN.
-. Vr = 2992.978 kN.
-. Ratio = Vu / Vr = 0.087 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 290.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 290.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111209,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            701.70      1890.92      1966.19      1033.66       982.72
           ---------------------------------------------------------------------------
            DL+LL+Others      701.70      1890.92      1966.19      1033.66       982.72
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1890.92 kN-m.
           -. End Moments (My2) =     1966.19 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1966.19 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1966.19 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      982.72 kN-m.
          -. End Moments (Mz2) =     1033.66 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      982.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      982.72 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1635.325 kN.
          -. Mry        =      4571.589 kN-m.
          -. Mrz        =      2274.846 kN-m.
          -. Mr         =      5106.305 kN-m.
          -. Pu/Pr      =   0.429  --->  O.K !
          -. Muy/Mry    =   0.430  --->  O.K !
          -. Muz/Mrz    =   0.432  --->  O.K !
          -. Mu/Mr      =   0.432  --->  O.K !
          -. Ratio      =   0.432  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        701.70 kN.
          -. Vuz    =        126.17 kN.
          -. Muy    =       1966.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        140.04 kN.
          -. Muz    =        982.72 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 126.17 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1303.25 kN.
-. phiVcz = phi * Vcz = 1172.92 kN.

-. Vuy = 140.04 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1303.25 kN.
-. phiVcy = phi * Vcy = 1172.92 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2156.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5845.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2156.72 kN.
-. phiVsz = phi*Vsz = 1941.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2156.72 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5845.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2156.72 kN.
-. phiVsy = phi*Vsy = 1941.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 188.497 kN.
-. Vr = 3113.968 kN.
-. Ratio = Vu / Vr = 0.061 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 209.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 209.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0061 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0061 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0061 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111210,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            701.67      1966.19      1995.78       982.72       923.31
           ---------------------------------------------------------------------------
            DL+LL+Others      701.67      1966.19      1995.78       982.72       923.31
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1966.19 kN-m.
           -. End Moments (My2) =     1995.78 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1966.19 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1966.19 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      923.31 kN-m.
          -. End Moments (Mz2) =      982.72 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      982.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      982.72 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1635.325 kN.
          -. Mry        =      4571.589 kN-m.
          -. Mrz        =      2274.846 kN-m.
          -. Mr         =      5106.305 kN-m.
          -. Pu/Pr      =   0.429  --->  O.K !
          -. Muy/Mry    =   0.430  --->  O.K !
          -. Muz/Mrz    =   0.432  --->  O.K !
          -. Mu/Mr      =   0.432  --->  O.K !
          -. Ratio      =   0.432  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        722.59 kN.
          -. Vuz    =         58.03 kN.
          -. Muy    =       1133.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.95 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.94

          -. Vuy    =        167.60 kN.
          -. Muz    =       1732.74 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.95 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.94
```

( ). Compute shear strength of concrete.
-. Vuz = 58.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1328.76 kN.
-. phiVcz = phi * Vcz = 1195.89 kN.

-. Vuy = 167.60 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1328.76 kN.
-. phiVcy = phi * Vcy = 1195.89 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2169.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5819.72 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2169.24 kN.
-. phiVsz = phi*Vsz = 1952.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2169.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5819.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2169.24 kN.
-. phiVsy = phi*Vsy = 1952.31 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 177.358 kN.
-. Vr = 3148.200 kN.
-. Ratio = Vu / Vr = 0.056 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 197.06 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 197.06 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0057 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0057 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0057 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111211,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            713.65      1995.78      1983.82       923.31       862.15
           ---------------------------------------------------------------------------
            DL+LL+Others      713.65      1995.78      1983.82       923.31       862.15
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1983.82 kN-m.
           -. End Moments (My2) =     1995.78 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1995.78 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1995.78 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      862.15 kN-m.
          -. End Moments (Mz2) =      923.31 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      923.31 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      923.31 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1670.920 kN.
          -. Mry        =      4636.751 kN-m.
          -. Mrz        =      2140.810 kN-m.
          -. Mr         =      5107.106 kN-m.
          -. Pu/Pr      =   0.427  --->  O.K !
          -. Muy/Mry    =   0.430  --->  O.K !
          -. Muz/Mrz    =   0.431  --->  O.K !
          -. Mu/Mr      =   0.431  --->  O.K !
          -. Ratio      =   0.431  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        734.57 kN.
          -. Vuz    =         37.81 kN.
          -. Muy    =       1169.88 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        201.52 kN.
          -. Muz    =       1658.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 37.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1331.22 kN.
-. phiVcz = phi * Vcz = 1198.10 kN.

-. Vuy = 201.52 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1331.22 kN.
-. phiVcy = phi * Vcy = 1198.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2170.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5817.27 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2170.42 kN.
-. phiVsz = phi*Vsz = 1953.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2170.42 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5817.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2170.42 kN.
-. phiVsy = phi*Vsy = 1953.38 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 205.041 kN.
-. Vr = 3151.479 kN.
-. Ratio = Vu / Vr = 0.065 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 227.82 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 227.82 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0056 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0056 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111212,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            725.62      1983.82      1935.08       862.15       794.72
           ------------------------------------------------------------------------------
            DL+LL+Others      725.62      1983.82      1935.08       862.15       794.72
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1935.08 kN-m.
           -. End Moments (My2) =     1983.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1983.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1983.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      794.72 kN-m.
          -. End Moments (Mz2) =      862.15 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      862.15 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      862.15 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1717.085 kN.
          -. Mry        =      4690.027 kN-m.
          -. Mrz        =      2033.652 kN-m.
          -. Mr         =      5111.956 kN-m.
          -. Pu/Pr      =   0.423  --->  O.K !
          -. Muy/Mry    =   0.423  --->  O.K !
          -. Muz/Mrz    =   0.424  --->  O.K !
          -. Mu/Mr      =   0.424  --->  O.K !
          -. Ratio      =   0.424  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        746.55 kN.
          -. Vuz    =         49.68 kN.
          -. Muy    =       1179.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96

          -. Vuy    =        229.05 kN.
          -. Muz    =       1569.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96
```

( ). Compute shear strength of concrete.
-. Vuz = 49.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1338.46 kN.
-. phiVcz = phi * Vcz = 1204.61 kN.

-. Vuy = 229.05 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1338.46 kN.
-. phiVcy = phi * Vcy = 1204.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2173.90 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5810.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2173.90 kN.
-. phiVsz = phi*Vsz = 1956.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2173.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5810.03 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2173.90 kN.
-. phiVsy = phi*Vsy = 1956.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 234.377 kN.
-. Vr = 3161.120 kN.
-. Ratio = Vu / Vr = 0.074 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 260.42 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 260.42 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0054 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0054 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0054 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111213,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            737.59      1935.08      1854.41       794.72       722.55
           ---------------------------------------------------------------------------
            DL+LL+Others      737.59      1935.08      1854.41       794.72       722.55
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1854.41 kN-m.
           -. End Moments (My2) =     1935.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1935.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1935.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      722.55 kN-m.
          -. End Moments (Mz2) =      794.72 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      794.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      794.72 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =      1810.714 kN.
           -. Mry        =      4736.270 kN-m.
           -. Mrz        =      1943.070 kN-m.
           -. Mr         =      5119.353 kN-m.
           -. Pu/Pr      =   0.407  --->  O.K !
           -. Muy/Mry    =   0.409  --->  O.K !
           -. Muz/Mrz    =   0.409  --->  O.K !
           -. Mu/Mr      =   0.409  --->  O.K !
           -. Ratio      =   0.409  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =        758.53 kN.
           -. Vuz    =         81.63 kN.
           -. Muy    =       1164.46 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.82 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.99

           -. Vuy    =        249.99 kN.
           -. Muz    =       1465.09 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.82 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.99
```

( ). Compute shear strength of concrete.
-. Vuz = 81.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1351.36 kN.
-. phiVcz = phi * Vcz = 1216.22 kN.

-. Vuy = 249.99 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1351.36 kN.
-. phiVcy = phi * Vcy = 1216.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2180.02 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5797.13 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2180.02 kN.
-. phiVsz = phi*Vsz = 1962.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2180.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5797.13 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2180.02 kN.
-. phiVsy = phi*Vsy = 1962.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 262.982 kN.
-. Vr = 3178.239 kN.
-. Ratio = Vu / Vr = 0.083 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 292.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 292.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111214,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            749.56      1854.41      1747.12       722.55       647.34
           ---------------------------------------------------------------------------
            DL+LL+Others      749.56      1854.41      1747.12       722.55       647.34
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1747.12 kN-m.
           -. End Moments (My2) =     1854.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1854.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1854.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      647.34 kN-m.
          -. End Moments (Mz2) =      722.55 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      722.55 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      722.55 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1945.574 kN.
          -. Mry        =      4779.547 kN-m.
          -. Mrz        =      1863.335 kN-m.
          -. Mr         =      5129.921 kN-m.
          -. Pu/Pr      =   0.385  --->  O.K !
          -. Muy/Mry    =   0.388  --->  O.K !
          -. Muz/Mrz    =   0.388  --->  O.K !
          -. Mu/Mr      =   0.388  --->  O.K !
          -. Ratio      =   0.388  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1802.03 kN.
          -. Vuz    =        121.69 kN.
          -. Muy    =      -1079.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89

          -. Vuy    =        249.74 kN.
          -. Muz    =      -1502.93 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.80
```

( ). Compute shear strength of concrete.
-. Vuz = 121.69 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1306.38 kN.
-. phiVcz = phi * Vcz = 1175.74 kN.

-. Vuy = 249.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1264.48 kN.
-. phiVcy = phi * Vcy = 1138.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2158.27 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5842.11 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2158.27 kN.
-. phiVsz = phi*Vsz = 1942.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2136.94 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5884.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2136.94 kN.
-. phiVsy = phi*Vsy = 1923.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 277.811 kN.
-. Vr = 3061.280 kN.
-. Ratio = Vu / Vr = 0.091 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 308.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 308.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111215,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            761.54      1747.12      1618.59       647.34       570.87
           ---------------------------------------------------------------------------
            DL+LL+Others      761.54      1747.12      1618.59       647.34       570.87
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1618.59 kN-m.
           -. End Moments (My2) =     1747.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1747.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1747.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      570.87 kN-m.
          -. End Moments (Mz2) =      647.34 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      647.34 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      647.34 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2088.888 kN.
          -. Mry        =      4818.462 kN-m.
          -. Mrz        =      1784.903 kN-m.
          -. Mr         =      5138.430 kN-m.
          -. Pu/Pr      =   0.365  --->  O.K !
          -. Muy/Mry    =   0.363  --->  O.K !
          -. Muz/Mrz    =   0.363  --->  O.K !
          -. Mu/Mr      =   0.365  --->  O.K !
          -. Ratio      =   0.365  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1839.65 kN.
          -. Vuz    =        262.91 kN.
          -. Muy    =      -1694.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        158.15 kN.
          -. Muz    =       -810.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.42 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.77
```

( ). Compute shear strength of concrete.
-. Vuz = 262.91 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1293.95 kN.
-. phiVcz = phi * Vcz = 1164.56 kN.

-. Vuy = 158.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1251.88 kN.
-. phiVcy = phi * Vcy = 1126.69 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2152.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5854.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2152.06 kN.
-. phiVsz = phi*Vsz = 1936.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2130.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5896.61 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2130.31 kN.
-. phiVsy = phi*Vsy = 1917.28 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 306.812 kN.
-. Vr = 3043.966 kN.
-. Ratio = Vu / Vr = 0.101 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 340.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 340.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111216,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            773.51      1618.59      1474.14       570.87       494.69
           ------------------------------------------------------------------------------
            DL+LL+Others      773.51      1618.59      1474.14       570.87       494.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1474.14 kN-m.
           -. End Moments (My2) =     1618.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1618.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1618.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      494.69 kN-m.
          -. End Moments (Mz2) =      570.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      570.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      570.87 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2324.955 kN.
          -. Mry        =      4859.822 kN-m.
          -. Mrz        =      1706.788 kN-m.
          -. Mr         =      5150.825 kN-m.
          -. Pu/Pr      =   0.333  --->  O.K !
          -. Muy/Mry    =   0.333  --->  O.K !
          -. Muz/Mrz    =   0.334  --->  O.K !
          -. Mu/Mr      =   0.334  --->  O.K !
          -. Ratio      =   0.334  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1856.32 kN.
          -. Vuz    =        290.30 kN.
          -. Muy    =      -1564.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.91

          -. Vuy    =        163.23 kN.
          -. Muz    =       -736.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.28 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.82
```

( ). Compute shear strength of concrete.
-. Vuz = 290.30 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1315.58 kN.
-. phiVcz = phi * Vcz = 1184.02 kN.

-. Vuy = 163.23 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1273.82 kN.
-. phiVcy = phi * Vcy = 1146.44 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2162.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5832.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2162.82 kN.
-. phiVsz = phi*Vsz = 1946.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2141.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5874.66 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2141.79 kN.
-. phiVsy = phi*Vsy = 1927.61 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 333.042 kN.
-. Vr = 3074.057 kN.
-. Ratio = Vu / Vr = 0.108 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 370.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 370.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111217,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            785.49      1474.14      1318.95       494.69       420.19
           ------------------------------------------------------------------------------
            DL+LL+Others      785.49      1474.14      1318.95       494.69       420.19
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1318.95 kN-m.
           -. End Moments (My2) =     1474.14 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1474.14 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1474.14 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      420.19 kN-m.
          -. End Moments (Mz2) =      494.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      494.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      494.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2609.259 kN.
          -. Mry        =      4901.663 kN-m.
          -. Mrz        =      1631.814 kN-m.
          -. Mr         =      5166.151 kN-m.
          -. Pu/Pr      =   0.301  --->  O.K !
          -. Muy/Mry    =   0.301  --->  O.K !
          -. Muz/Mrz    =   0.303  --->  O.K !
          -. Mu/Mr      =   0.303  --->  O.K !
          -. Ratio      =   0.303  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1872.99 kN.
          -. Vuz    =        308.69 kN.
          -. Muy    =      -1419.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97

          -. Vuy    =        165.44 kN.
          -. Muz    =       -658.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 308.69 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1342.21 kN.
-. phiVcz = phi * Vcz = 1207.99 kN.

-. Vuy = 165.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1300.90 kN.
-. phiVcy = phi * Vcy = 1170.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2175.68 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5806.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2175.68 kN.
-. phiVsz = phi*Vsz = 1958.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2155.54 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5847.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2155.54 kN.
-. phiVsy = phi*Vsy = 1939.99 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 350.229 kN.
-. Vr = 3110.798 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 389.14 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 389.14 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111218,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1889.66     -1265.05     -1105.87      -578.30      -498.41
           ---------------------------------------------------------------------------
            DL+LL+Others     1889.66     -1265.05     -1105.87      -578.30      -498.41
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1105.87 kN-m.
           -. End Moments (My2) =     1265.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1265.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1265.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      498.41 kN-m.
          -. End Moments (Mz2) =      578.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -578.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -578.30 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      6983.187 kN.
          -. Mry        =      4678.942 kN-m.
          -. Mrz        =      2143.860 kN-m.
          -. Mr         =      5146.711 kN-m.
          -. Pu/Pr      =   0.271  --->  O.K !
          -. Muy/Mry    =   0.270  --->  O.K !
          -. Muz/Mrz    =   0.270  --->  O.K !
          -. Mu/Mr      =   0.271  --->  O.K !
          -. Ratio      =   0.271  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1889.66 kN.
          -. Vuz    =        318.58 kN.
          -. Muy    =      -1265.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        164.21 kN.
          -. Muz    =       -578.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 318.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1373.34 kN.
-. phiVcz = phi * Vcz = 1236.00 kN.

-. Vuy = 164.21 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1332.61 kN.
-. phiVcy = phi * Vcy = 1199.35 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2190.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5775.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2190.23 kN.
-. phiVsz = phi*Vsz = 1971.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2171.09 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5815.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2171.09 kN.
-. phiVsy = phi*Vsy = 1953.99 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 358.414 kN.
-. Vr = 3153.336 kN.
-. Ratio = Vu / Vr = 0.114 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 398.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 398.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111219,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1906.34     -1105.87      -946.24      -498.41      -420.86
           ------------------------------------------------------------------------------
            DL+LL+Others     1906.34     -1105.87      -946.24      -498.41      -420.86
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      946.24 kN-m.
           -. End Moments (My2) =     1105.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1105.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1105.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      420.86 kN-m.
          -. End Moments (Mz2) =      498.41 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -498.41 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -498.41 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =      8001.490 kN.
           -. Mry        =      4605.577 kN-m.
           -. Mrz        =      2079.680 kN-m.
           -. Mr         =      5053.356 kN-m.
           -. Pu/Pr      =   0.238  --->  O.K !
           -. Muy/Mry    =   0.240  --->  O.K !
           -. Muz/Mrz    =   0.240  --->  O.K !
           -. Mu/Mr      =   0.240  --->  O.K !
           -. Ratio      =   0.240  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       1906.34 kN.
           -. Vuz    =        319.40 kN.
           -. Muy    =      -1105.87 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.52 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.12

           -. Vuy    =        159.17 kN.
           -. Muz    =       -498.41 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.73 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.03
```

( ). Compute shear strength of concrete.
-. Vuz = 319.40 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1408.66 kN.
-. phiVcz = phi * Vcz = 1267.79 kN.

-. Vuy = 159.17 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1368.69 kN.
-. phiVcy = phi * Vcy = 1231.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2206.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5739.83 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2206.11 kN.
-. phiVsz = phi*Vsz = 1985.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2188.09 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5779.80 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2188.09 kN.
-. phiVsy = phi*Vsy = 1969.28 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 356.862 kN.
-. Vr = 3201.103 kN.
-. Ratio = Vu / Vr = 0.111 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 396.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 396.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111220,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1923.01      -946.24      -791.35      -420.86      -347.66
           ------------------------------------------------------------------------------
            DL+LL+Others     1923.01      -946.24      -791.35      -420.86      -347.66
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      791.35 kN-m.
           -. End Moments (My2) =      946.24 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -946.24 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -946.24 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      347.66 kN-m.
          -. End Moments (Mz2) =      420.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -420.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -420.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9036.720 kN.
          -. Mry        =      4493.339 kN-m.
          -. Mrz        =      1989.397 kN-m.
          -. Mr         =      4914.041 kN-m.
          -. Pu/Pr      =   0.213  --->  O.K !
          -. Muy/Mry    =   0.211  --->  O.K !
          -. Muz/Mrz    =   0.212  --->  O.K !
          -. Mu/Mr      =   0.213  --->  O.K !
          -. Ratio      =   0.213  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1923.01 kN.
          -. Vuz    =        309.90 kN.
          -. Muy    =       -946.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.20

          -. Vuy    =        150.33 kN.
          -. Muz    =       -420.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.52 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.12
```

( ). Compute shear strength of concrete.
-. Vuz = 309.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1447.80 kN.
-. phiVcz = phi * Vcz = 1303.02 kN.

-. Vuy = 150.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1408.78 kN.
-. phiVcy = phi * Vcy = 1267.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2222.98 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5700.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2222.98 kN.
-. phiVsz = phi*Vsz = 2000.69 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2206.16 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5739.70 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2206.16 kN.
-. phiVsy = phi*Vsy = 1985.55 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 344.435 kN.
-. Vr = 3253.451 kN.
-. Ratio = Vu / Vr = 0.106 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 382.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 382.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111221,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1939.68      -791.35      -645.33      -347.66      -280.39
           ------------------------------------------------------------------------------
            DL+LL+Others     1939.68      -791.35      -645.33      -347.66      -280.39
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      645.33 kN-m.
           -. End Moments (My2) =      791.35 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -791.35 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -791.35 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      280.39 kN-m.
          -. End Moments (Mz2) =      347.66 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -347.66 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -347.66 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10783.337 kN.
          -. Mry        =      4355.307 kN-m.
          -. Mrz        =      1917.262 kN-m.
          -. Mr         =      4758.633 kN-m.
          -. Pu/Pr      =   0.180  --->  O.K !
          -. Muy/Mry    =   0.182  --->  O.K !
          -. Muz/Mrz    =   0.181  --->  O.K !
          -. Mu/Mr      =   0.182  --->  O.K !
          -. Ratio      =   0.182  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1939.68 kN.
          -. Vuz    =        292.14 kN.
          -. Muy    =       -791.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.30

          -. Vuy    =        138.58 kN.
          -. Muz    =       -347.66 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.30 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.21
```

( ). Compute shear strength of concrete.
-. Vuz = 292.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1489.51 kN.
-. phiVcz = phi * Vcz = 1340.56 kN.

-. Vuy = 138.58 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1451.63 kN.
-. phiVcy = phi * Vcy = 1306.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2240.18 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5658.98 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2240.18 kN.
-. phiVsz = phi*Vsz = 2016.16 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2224.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5696.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2224.59 kN.
-. phiVsy = phi*Vsy = 2002.13 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 323.339 kN.
-. Vr = 3308.598 kN.
-. Ratio = Vu / Vr = 0.098 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 359.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 359.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111222,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1956.35      -645.33      -511.31      -280.39      -220.23
           ------------------------------------------------------------------------------
            DL+LL+Others     1956.35      -645.33      -511.31      -280.39      -220.23
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      511.31 kN-m.
           -. End Moments (My2) =      645.33 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -645.33 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -645.33 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      220.23 kN-m.
          -. End Moments (Mz2) =      280.39 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -280.39 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -280.39 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12778.834 kN.
          -. Mry        =      4182.836 kN-m.
          -. Mrz        =      1821.751 kN-m.
          -. Mr         =      4562.334 kN-m.
          -. Pu/Pr      =   0.153  --->  O.K !
          -. Muy/Mry    =   0.154  --->  O.K !
          -. Muz/Mrz    =   0.154  --->  O.K !
          -. Mu/Mr      =   0.154  --->  O.K !
          -. Ratio      =   0.154  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1956.35 kN.
          -. Vuz    =        268.12 kN.
          -. Muy    =       -645.33 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.39

          -. Vuy    =        124.80 kN.
          -. Muz    =       -280.39 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.31
```

( ). Compute shear strength of concrete.
-. Vuz = 268.12 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1532.46 kN.
-. phiVcz = phi * Vcz = 1379.21 kN.

-. Vuy = 124.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1495.89 kN.
-. phiVcy = phi * Vcy = 1346.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2257.10 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5616.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2257.10 kN.
-. phiVsz = phi*Vsz = 2031.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2242.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5652.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2242.74 kN.
-. phiVsy = phi*Vsy = 2018.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 295.745 kN.
-. Vr = 3364.773 kN.
-. Ratio = Vu / Vr = 0.088 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 328.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 328.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111223,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1973.02      -511.31      -391.50      -220.23      -168.03
           ------------------------------------------------------------------------------
            DL+LL+Others     1973.02      -511.31      -391.50      -220.23      -168.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      391.50 kN-m.
           -. End Moments (My2) =      511.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -511.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -511.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      168.03 kN-m.
          -. End Moments (Mz2) =      220.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -220.23 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -220.23 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15195.117 kN.
          -. Mry        =      3915.213 kN-m.
          -. Mrz        =      1687.737 kN-m.
          -. Mr         =      4263.490 kN-m.
          -. Pu/Pr      =   0.130  --->  O.K !
          -. Muy/Mry    =   0.131  --->  O.K !
          -. Muz/Mrz    =   0.130  --->  O.K !
          -. Mu/Mr      =   0.131  --->  O.K !
          -. Ratio      =   0.131  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1973.02 kN.
          -. Vuz    =        239.72 kN.
          -. Muy    =       -511.31 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.49

          -. Vuy    =        109.71 kN.
          -. Muz    =       -220.23 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.90 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.41
```

( ). Compute shear strength of concrete.
-. Vuz = 239.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1575.34 kN.
-. phiVcz = phi * Vcz = 1417.81 kN.

-. Vuy = 109.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1540.23 kN.
-. phiVcy = phi * Vcy = 1386.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2273.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5573.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2273.24 kN.
-. phiVsz = phi*Vsz = 2045.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2260.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5608.26 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2260.08 kN.
-. phiVsy = phi*Vsy = 2034.07 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 263.638 kN.
-. Vr = 3420.272 kN.
-. Ratio = Vu / Vr = 0.077 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 292.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 292.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111224,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1989.69      -391.50      -287.24      -168.03      -124.34
           ------------------------------------------------------------------------------
            DL+LL+Others     1989.69      -391.50      -287.24      -168.03      -124.34
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      287.24 kN-m.
           -. End Moments (My2) =      391.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -391.50 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -391.50 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      124.34 kN-m.
          -. End Moments (Mz2) =      168.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -168.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -168.03 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17891.993 kN.
          -. Mry        =      3524.810 kN-m.
          -. Mrz        =      1503.911 kN-m.
          -. Mr         =      3832.236 kN-m.
          -. Pu/Pr      =   0.111  --->  O.K !
          -. Muy/Mry    =   0.111  --->  O.K !
          -. Muz/Mrz    =   0.112  --->  O.K !
          -. Mu/Mr      =   0.112  --->  O.K !
          -. Ratio      =   0.112  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1989.69 kN.
          -. Vuz    =        208.60 kN.
          -. Muy    =       -391.50 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.58

          -. Vuy    =         94.01 kN.
          -. Muz    =       -168.03 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.73 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.50
```

( ). Compute shear strength of concrete.
-. Vuz = 208.60 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1616.84 kN.
-. phiVcz = phi * Vcz = 1455.16 kN.

-. Vuy = 94.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1583.27 kN.
-. phiVcy = phi * Vcy = 1424.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2288.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5531.65 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2288.20 kN.
-. phiVsz = phi*Vsz = 2059.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2276.15 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5565.22 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2276.15 kN.
-. phiVsy = phi*Vsy = 2048.53 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 228.810 kN.
-. Vr = 3473.478 kN.
-. Ratio = Vu / Vr = 0.066 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 254.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 254.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111225,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2416.30       -79.07       -54.30       -78.83       -62.25
           ------------------------------------------------------------------------------
            DL+LL+Others     2416.30       -79.07       -54.30       -78.83       -62.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       54.30 kN-m.
           -. End Moments (My2) =       79.07 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -54.30 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -54.30 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       62.25 kN-m.
          -. End Moments (Mz2) =       78.83 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -62.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -62.25 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       548.847 kN-m.
          -. Mrz        =       628.281 kN-m.
          -. Mr         =       834.248 kN-m.
          -. Pu/Pr      =   0.099  --->  O.K !
          -. Muy/Mry    =   0.099  --->  O.K !
          -. Muz/Mrz    =   0.099  --->  O.K !
          -. Mu/Mr      =   0.099  --->  O.K !
          -. Ratio      =   0.099  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2006.35 kN.
          -. Vuz    =        176.20 kN.
          -. Muy    =       -287.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.45 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.66

          -. Vuy    =         78.28 kN.
          -. Muz    =       -124.34 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.57 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.59
```

( ). Compute shear strength of concrete.
-. Vuz = 176.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1655.73 kN.
-. phiVcz = phi * Vcz = 1490.16 kN.

-. Vuy = 78.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1623.73 kN.
-. phiVcy = phi * Vcy = 1461.36 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2301.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5492.76 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2301.66 kN.
-. phiVsz = phi*Vsz = 2071.49 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2290.62 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5524.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2290.62 kN.
-. phiVsy = phi*Vsy = 2061.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 192.804 kN.
-. Vr = 3522.917 kN.
-. Ratio = Vu / Vr = 0.055 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 214.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 214.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111226,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2432.95       -54.30       -34.16       -62.25       -47.77
           ------------------------------------------------------------------------------
            DL+LL+Others     2432.95       -54.30       -34.16       -62.25       -47.77
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       34.16 kN-m.
           -. End Moments (My2) =       54.30 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -34.16 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -34.16 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       47.77 kN-m.
          -. End Moments (Mz2) =       62.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -47.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -47.77 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       342.878 kN-m.
          -. Mrz        =       479.000 kN-m.
          -. Mr         =       589.072 kN-m.
          -. Pu/Pr      =   0.100  --->  O.K !
          -. Muy/Mry    =   0.100  --->  O.K !
          -. Muz/Mrz    =   0.100  --->  O.K !
          -. Mu/Mr      =   0.100  --->  O.K !
          -. Ratio      =   0.100  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2023.02 kN.
          -. Vuz    =        143.70 kN.
          -. Muy    =       -199.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.74

          -. Vuy    =         62.99 kN.
          -. Muz    =        -89.49 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.68
```

( ). Compute shear strength of concrete.
-. Vuz = 143.70 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1690.91 kN.
-. phiVcz = phi * Vcz = 1521.82 kN.

-. Vuy = 62.99 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1660.43 kN.
-. phiVcy = phi * Vcy = 1494.39 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2313.40 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5457.58 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2313.40 kN.
-. phiVsz = phi*Vsz = 2082.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2303.25 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5488.06 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2303.25 kN.
-. phiVsy = phi*Vsy = 2072.93 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 156.900 kN.
-. Vr = 3567.312 kN.
-. Ratio = Vu / Vr = 0.044 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 174.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 174.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111227,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2449.61       -34.16       -18.52       -47.77       -36.38
           ---------------------------------------------------------------------------
            DL+LL+Others     2449.61       -34.16       -18.52       -47.77       -36.38
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       18.52 kN-m.
           -. End Moments (My2) =       34.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -18.52 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -18.52 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       36.38 kN-m.
          -. End Moments (Mz2) =       47.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -36.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -36.38 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       184.774 kN-m.
          -. Mrz        =       362.264 kN-m.
          -. Mr         =       406.665 kN-m.
          -. Pu/Pr      =   0.100  --->  O.K !
          -. Muy/Mry    =   0.100  --->  O.K !
          -. Muz/Mrz    =   0.100  --->  O.K !
          -. Mu/Mr      =   0.100  --->  O.K !
          -. Ratio      =   0.100  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2039.69 kN.
          -. Vuz    =        112.06 kN.
          -. Muy    =       -127.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.81

          -. Vuy    =         48.53 kN.
          -. Muz    =        -63.31 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.75
```

( ). Compute shear strength of concrete.
-. Vuz = 112.06 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1721.46 kN.
-. phiVcz = phi * Vcz = 1549.31 kN.

-. Vuy = 48.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1692.38 kN.
-. phiVcy = phi * Vcy = 1523.14 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2323.27 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5427.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2323.27 kN.
-. phiVsz = phi*Vsz = 2090.94 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2313.88 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5456.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2313.88 kN.
-. phiVsy = phi*Vsy = 2082.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 122.115 kN.
-. Vr = 3605.637 kN.
-. Ratio = Vu / Vr = 0.034 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 135.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 135.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111228,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2466.26       -18.52        -7.13       -36.38       -27.54
           ------------------------------------------------------------------------------
            DL+LL+Others     2466.26       -18.52        -7.13       -36.38       -27.54
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.13 kN-m.
           -. End Moments (My2) =       18.52 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.13 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.13 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       27.54 kN-m.
          -. End Moments (Mz2) =       36.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -27.54 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -27.54 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        70.358 kN-m.
          -. Mrz        =       272.604 kN-m.
          -. Mr         =       281.537 kN-m.
          -. Pu/Pr      =   0.101  --->  O.K !
          -. Muy/Mry    =   0.101  --->  O.K !
          -. Muz/Mrz    =   0.101  --->  O.K !
          -. Mu/Mr      =   0.101  --->  O.K !
          -. Ratio      =   0.101  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2056.35 kN.
          -. Vuz    =         81.99 kN.
          -. Muy    =        -71.54 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.87

          -. Vuy    =         35.22 kN.
          -. Muz    =        -46.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.22 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.80
```

( ). Compute shear strength of concrete.
-. Vuz = 81.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1746.47 kN.
-. phiVcz = phi * Vcz = 1571.82 kN.

-. Vuy = 35.22 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1718.59 kN.
-. phiVcy = phi * Vcy = 1546.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2331.14 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5402.02 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2331.14 kN.
-. phiVsz = phi*Vsz = 2098.03 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2322.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5429.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2322.36 kN.
-. phiVsy = phi*Vsy = 2090.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 89.233 kN.
-. Vr = 3636.855 kN.
-. Ratio = Vu / Vr = 0.025 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 99.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 99.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111229,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2482.92        -7.13        -8.22       -27.54       -20.75
           ------------------------------------------------------------------------------
            DL+LL+Others     2482.92        -7.13        -8.22       -27.54       -20.75
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.13 kN-m.
           -. End Moments (My2) =        8.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       20.75 kN-m.
          -. End Moments (Mz2) =       27.54 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -20.75 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -20.75 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        80.989 kN-m.
          -. Mrz        =       203.904 kN-m.
          -. Mr         =       219.399 kN-m.
          -. Pu/Pr      =   0.102  --->  O.K !
          -. Muy/Mry    =   0.102  --->  O.K !
          -. Muz/Mrz    =   0.102  --->  O.K !
          -. Mu/Mr      =   0.102  --->  O.K !
          -. Ratio      =   0.102  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2089.68 kN.
          -. Vuz    =         58.08 kN.
          -. Muy    =         -5.64 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =         25.05 kN.
          -. Muz    =        -43.06 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 58.08 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1759.01 kN.
-. phiVcz = phi * Vcz = 1583.11 kN.

-. Vuy = 25.05 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1731.76 kN.
-. phiVcy = phi * Vcy = 1558.58 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2335.02 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5389.47 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2335.02 kN.
-. phiVsz = phi*Vsz = 2101.52 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2326.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5416.73 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2326.53 kN.
-. phiVsy = phi*Vsy = 2093.88 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 63.257 kN.
-. Vr = 3652.463 kN.
-. Ratio = Vu / Vr = 0.017 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 70.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 70.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111230,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2499.58        -8.22       -10.07       -20.75       -15.08
           ------------------------------------------------------------------------------
            DL+LL+Others     2499.58        -8.22       -10.07       -20.75       -15.08
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.22 kN-m.
           -. End Moments (My2) =       10.07 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -10.07 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -10.07 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       15.08 kN-m.
          -. End Moments (Mz2) =       20.75 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -15.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -15.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        98.325 kN-m.
          -. Mrz        =       147.297 kN-m.
          -. Mr         =       177.099 kN-m.
          -. Pu/Pr      =   0.102  --->  O.K !
          -. Muy/Mry    =   0.102  --->  O.K !
          -. Muz/Mrz    =   0.102  --->  O.K !
          -. Mu/Mr      =   0.102  --->  O.K !
          -. Ratio      =   0.102  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2106.34 kN.
          -. Vuz    =         43.84 kN.
          -. Muy    =        -20.50 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =         19.28 kN.
          -. Muz    =        -41.11 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 43.84 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1763.88 kN.
-. phiVcz = phi * Vcz = 1587.49 kN.

-. Vuy = 19.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1736.87 kN.
-. phiVcy = phi * Vcy = 1563.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2336.51 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5384.60 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2336.51 kN.
-. phiVsz = phi*Vsz = 2102.86 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2328.14 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5411.61 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2328.14 kN.
-. phiVsy = phi*Vsy = 2095.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 47.895 kN.
-. Vr = 3658.513 kN.
-. Ratio = Vu / Vr = 0.013 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 53.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 53.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111231,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2516.23       -10.07       -12.54       -15.08       -10.65
           ------------------------------------------------------------------------------
            DL+LL+Others     2516.23       -10.07       -12.54       -15.08       -10.65
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       10.07 kN-m.
           -. End Moments (My2) =       12.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -12.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -12.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       10.65 kN-m.
          -. End Moments (Mz2) =       15.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -10.65 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -10.65 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       121.701 kN-m.
          -. Mrz        =       103.293 kN-m.
          -. Mr         =       159.627 kN-m.
          -. Pu/Pr      =   0.103  --->  O.K !
          -. Muy/Mry    =   0.103  --->  O.K !
          -. Muz/Mrz    =   0.103  --->  O.K !
          -. Mu/Mr      =   0.103  --->  O.K !
          -. Ratio      =   0.103  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2123.01 kN.
          -. Vuz    =         31.30 kN.
          -. Muy    =        -35.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =         14.46 kN.
          -. Muz    =        -38.60 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 31.30 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1763.24 kN.
-. phiVcz = phi * Vcz = 1586.92 kN.

-. Vuy = 14.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1736.20 kN.
-. phiVcy = phi * Vcy = 1562.58 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2336.31 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5385.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2336.31 kN.
-. phiVsz = phi*Vsz = 2102.68 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.93 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5412.29 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.93 kN.
-. phiVsy = phi*Vsy = 2095.14 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 34.477 kN.
-. Vr = 3657.719 kN.
-. Ratio = Vu / Vr = 0.009 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 38.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 38.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111232,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2532.89       -12.54       -14.12       -10.65        -7.84
           ------------------------------------------------------------------------------
            DL+LL+Others     2532.89       -12.54       -14.12       -10.65        -7.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       12.54 kN-m.
           -. End Moments (My2) =       14.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -14.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -14.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        7.84 kN-m.
          -. End Moments (Mz2) =       10.65 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -7.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -7.84 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       136.100 kN-m.
          -. Mrz        =        75.498 kN-m.
          -. Mr         =       155.638 kN-m.
          -. Pu/Pr      =   0.104  --->  O.K !
          -. Muy/Mry    =   0.104  --->  O.K !
          -. Muz/Mrz    =   0.104  --->  O.K !
          -. Mu/Mr      =   0.104  --->  O.K !
          -. Ratio      =   0.104  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2139.67 kN.
          -. Vuz    =         20.45 kN.
          -. Muy    =        -45.84 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =         10.58 kN.
          -. Muz    =        -35.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 20.45 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1762.22 kN.
-. phiVcz = phi * Vcz = 1586.00 kN.

-. Vuy = 10.58 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1735.13 kN.
-. phiVcy = phi * Vcy = 1561.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2336.00 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5386.27 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2336.00 kN.
-. phiVsz = phi*Vsz = 2102.40 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5413.36 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.59 kN.
-. phiVsy = phi*Vsy = 2094.83 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 23.029 kN.
-. Vr = 3656.447 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 25.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 25.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111233,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2549.54       -14.12       -14.84        -7.84        -5.51
           ------------------------------------------------------------------------------
            DL+LL+Others     2549.54       -14.12       -14.84        -7.84        -5.51
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       14.12 kN-m.
           -. End Moments (My2) =       14.84 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -14.84 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -14.84 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        5.51 kN-m.
          -. End Moments (Mz2) =        7.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -5.51 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -5.51 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       142.087 kN-m.
          -. Mrz        =        52.623 kN-m.
          -. Mr         =       151.519 kN-m.
          -. Pu/Pr      =   0.104  --->  O.K !
          -. Muy/Mry    =   0.104  --->  O.K !
          -. Muz/Mrz    =   0.105  --->  O.K !
          -. Mu/Mr      =   0.105  --->  O.K !
          -. Ratio      =   0.105  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2156.33 kN.
          -. Vuz    =         11.27 kN.
          -. Muy    =        -51.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =          8.21 kN.
          -. Muz    =        -32.29 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 11.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1761.41 kN.
-. phiVcz = phi * Vcz = 1585.27 kN.

-. Vuy = 8.21 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1734.28 kN.
-. phiVcy = phi * Vcy = 1560.85 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2335.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5387.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2335.75 kN.
-. phiVsz = phi*Vsz = 2102.18 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5414.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.33 kN.
-. phiVsy = phi*Vsy = 2094.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 13.944 kN.
-. Vr = 3655.445 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 15.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 15.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111234,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2566.20       -14.84       -15.10        -5.51        -3.95
           ------------------------------------------------------------------------------
            DL+LL+Others     2566.20       -14.84       -15.10        -5.51        -3.95
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       14.84 kN-m.
           -. End Moments (My2) =       15.10 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -15.10 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -15.10 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.95 kN-m.
          -. End Moments (Mz2) =        5.51 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.95 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       143.647 kN-m.
          -. Mrz        =        37.603 kN-m.
          -. Mr         =       148.487 kN-m.
          -. Pu/Pr      =   0.105  --->  O.K !
          -. Muy/Mry    =   0.105  --->  O.K !
          -. Muz/Mrz    =   0.105  --->  O.K !
          -. Mu/Mr      =   0.105  --->  O.K !
          -. Ratio      =   0.105  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2151.99 kN.
          -. Vuz    =          4.10 kN.
          -. Muy    =        -30.82 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =          8.66 kN.
          -. Muz    =        -50.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 4.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1764.03 kN.
-. phiVcz = phi * Vcz = 1587.62 kN.

-. Vuy = 8.66 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1737.02 kN.
-. phiVcy = phi * Vcy = 1563.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2336.55 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5384.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2336.55 kN.
-. phiVsz = phi*Vsz = 2102.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2328.19 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5411.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2328.19 kN.
-. phiVsy = phi*Vsy = 2095.37 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 9.585 kN.
-. Vr = 3658.691 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.65 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.65 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111235,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2582.85       -15.10       -14.89        -3.95        -3.00
           ------------------------------------------------------------------------------
            DL+LL+Others     2582.85       -15.10       -14.89        -3.95        -3.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       14.89 kN-m.
           -. End Moments (My2) =       15.10 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -14.89 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -14.89 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.00 kN-m.
          -. End Moments (Mz2) =        3.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       140.742 kN-m.
          -. Mrz        =        28.261 kN-m.
          -. Mr         =       143.551 kN-m.
          -. Pu/Pr      =   0.106  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.106  --->  O.K !
          -. Mu/Mr      =   0.106  --->  O.K !
          -. Ratio      =   0.106  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2168.65 kN.
          -. Vuz    =          1.92 kN.
          -. Muy    =        -31.10 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =         10.50 kN.
          -. Muz    =        -45.23 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 1.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1762.66 kN.
-. phiVcz = phi * Vcz = 1586.39 kN.

-. Vuy = 10.50 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1735.59 kN.
-. phiVcy = phi * Vcy = 1562.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2336.13 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5385.83 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2336.13 kN.
-. phiVsz = phi*Vsz = 2102.52 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5412.90 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.74 kN.
-. phiVsy = phi*Vsy = 2094.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 10.675 kN.
-. Vr = 3656.990 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 11.86 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 11.86 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111236,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2599.51       -14.89       -13.96        -3.00        -2.44
           ------------------------------------------------------------------------------
            DL+LL+Others     2599.51       -14.89       -13.96        -3.00        -2.44
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.96 kN-m.
           -. End Moments (My2) =       14.89 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        2.44 kN-m.
          -. End Moments (Mz2) =        3.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -2.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -2.44 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       131.121 kN-m.
          -. Mrz        =        22.779 kN-m.
          -. Mr         =       133.085 kN-m.
          -. Pu/Pr      =   0.107  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2185.31 kN.
          -. Vuz    =          3.43 kN.
          -. Muy    =        -29.61 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =         11.66 kN.
          -. Muz    =        -39.70 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 3.43 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1761.63 kN.
-. phiVcz = phi * Vcz = 1585.47 kN.

-. Vuy = 11.66 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1734.51 kN.
-. phiVcy = phi * Vcy = 1561.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2335.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5386.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2335.82 kN.
-. phiVsz = phi*Vsz = 2102.24 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.40 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5413.98 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.40 kN.
-. phiVsy = phi*Vsy = 2094.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 12.158 kN.
-. Vr = 3655.717 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 13.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 13.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111237,  LCB = 148-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2599.51       -13.96       -12.53        -2.44        -2.00
           ------------------------------------------------------------------------------
            DL+LL+Others     2599.51       -13.96       -12.53        -2.44        -2.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       12.53 kN-m.
           -. End Moments (My2) =       13.96 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        2.00 kN-m.
          -. End Moments (Mz2) =        2.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -2.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -2.44 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       131.121 kN-m.
          -. Mrz        =        22.779 kN-m.
          -. Mr         =       133.085 kN-m.
          -. Pu/Pr      =   0.107  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2201.97 kN.
          -. Vuz    =          5.87 kN.
          -. Muy    =        -26.75 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =         12.24 kN.
          -. Muz    =        -33.74 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.84
```

( ). Compute shear strength of concrete.
-. Vuz = 5.87 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1760.99 kN.
-. phiVcz = phi * Vcz = 1584.89 kN.

-. Vuy = 12.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1733.83 kN.
-. phiVcy = phi * Vcy = 1560.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2335.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5387.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2335.62 kN.
-. phiVsz = phi*Vsz = 2102.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2327.19 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5414.65 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2327.19 kN.
-. phiVsy = phi*Vsy = 2094.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 13.577 kN.
-. Vr = 3654.917 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 15.09 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 15.09 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111238,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2632.82       -12.53       -10.75        -2.00        -1.59
           ------------------------------------------------------------------------------
            DL+LL+Others     2632.82       -12.53       -10.75        -2.00        -1.59
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       10.75 kN-m.
           -. End Moments (My2) =       12.53 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -10.75 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -10.75 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.59 kN-m.
          -. End Moments (Mz2) =        2.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.59 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.59 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        99.600 kN-m.
          -. Mrz        =        14.766 kN-m.
          -. Mr         =       100.688 kN-m.
          -. Pu/Pr      =   0.108  --->  O.K !
          -. Muy/Mry    =   0.108  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.108  --->  O.K !
          -. Ratio      =   0.108  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2222.99 kN.
          -. Vuz    =         13.12 kN.
          -. Muy    =        -44.46 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          7.13 kN.
          -. Muz    =        -18.32 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 13.12 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1755.98 kN.
-. phiVcz = phi * Vcz = 1580.38 kN.

-. Vuy = 7.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.57 kN.
-. phiVcy = phi * Vcy = 1555.71 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2334.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5392.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2334.08 kN.
-. phiVsz = phi*Vsz = 2100.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5419.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.53 kN.
-. phiVsy = phi*Vsy = 2092.97 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 14.929 kN.
-. Vr = 3648.688 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 16.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 16.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111239,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2649.48       -10.75        -8.83        -1.59        -1.19
           ------------------------------------------------------------------------------
            DL+LL+Others     2649.48       -10.75        -8.83        -1.59        -1.19
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.83 kN-m.
           -. End Moments (My2) =       10.75 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.19 kN-m.
          -. End Moments (Mz2) =        1.59 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.19 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.19 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        81.325 kN-m.
          -. Mrz        =        10.970 kN-m.
          -. Mr         =        82.062 kN-m.
          -. Pu/Pr      =   0.109  --->  O.K !
          -. Muy/Mry    =   0.109  --->  O.K !
          -. Muz/Mrz    =   0.108  --->  O.K !
          -. Mu/Mr      =   0.109  --->  O.K !
          -. Ratio      =   0.109  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2239.65 kN.
          -. Vuz    =         13.93 kN.
          -. Muy    =        -37.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          6.90 kN.
          -. Muz    =        -14.84 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 13.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1755.86 kN.
-. phiVcz = phi * Vcz = 1580.27 kN.

-. Vuy = 6.90 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.45 kN.
-. phiVcy = phi * Vcy = 1555.60 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2334.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5392.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2334.05 kN.
-. phiVsz = phi*Vsz = 2100.64 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5420.04 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.49 kN.
-. phiVsy = phi*Vsy = 2092.94 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.548 kN.
-. Vr = 3648.542 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111240,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2666.13        -8.83        -6.80        -1.19        -0.83
           ------------------------------------------------------------------------------
            DL+LL+Others     2666.13        -8.83        -6.80        -1.19        -0.83
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        6.80 kN-m.
           -. End Moments (My2) =        8.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -6.80 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -6.80 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.83 kN-m.
          -. End Moments (Mz2) =        1.19 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.83 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.83 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        62.226 kN-m.
          -. Mrz        =         7.626 kN-m.
          -. Mr         =        62.692 kN-m.
          -. Pu/Pr      =   0.109  --->  O.K !
          -. Muy/Mry    =   0.109  --->  O.K !
          -. Muz/Mrz    =   0.109  --->  O.K !
          -. Mu/Mr      =   0.109  --->  O.K !
          -. Ratio      =   0.109  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2256.31 kN.
          -. Vuz    =         14.56 kN.
          -. Muy    =        -30.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          6.40 kN.
          -. Muz    =        -11.44 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 14.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1755.93 kN.
-. phiVcz = phi * Vcz = 1580.34 kN.

-. Vuy = 6.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.52 kN.
-. phiVcy = phi * Vcy = 1555.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2334.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5392.56 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2334.07 kN.
-. phiVsz = phi*Vsz = 2100.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5419.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.51 kN.
-. phiVsy = phi*Vsy = 2092.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.901 kN.
-. Vr = 3648.629 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111241,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2682.79        -6.80        -4.78        -0.83        -0.54
           ------------------------------------------------------------------------------
            DL+LL+Others     2682.79        -6.80        -4.78        -0.83        -0.54
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.78 kN-m.
           -. End Moments (My2) =        6.80 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.78 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.78 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.54 kN-m.
          -. End Moments (Mz2) =        0.83 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.54 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.54 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        43.441 kN-m.
          -. Mrz        =         4.888 kN-m.
          -. Mr         =        43.715 kN-m.
          -. Pu/Pr      =   0.110  --->  O.K !
          -. Muy/Mry    =   0.110  --->  O.K !
          -. Muz/Mrz    =   0.110  --->  O.K !
          -. Mu/Mr      =   0.110  --->  O.K !
          -. Ratio      =   0.110  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2272.96 kN.
          -. Vuz    =         14.27 kN.
          -. Muy    =        -23.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          5.56 kN.
          -. Muz    =         -8.26 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 14.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1756.33 kN.
-. phiVcz = phi * Vcz = 1580.70 kN.

-. Vuy = 5.56 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.94 kN.
-. phiVcy = phi * Vcy = 1556.05 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2334.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5392.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2334.19 kN.
-. phiVsz = phi*Vsz = 2100.77 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.64 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5419.54 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.64 kN.
-. phiVsy = phi*Vsy = 2093.08 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.316 kN.
-. Vr = 3649.130 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.02 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.02 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111242,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2699.44        -4.78        -2.93        -0.54        -0.31
           ------------------------------------------------------------------------------
            DL+LL+Others     2699.44        -4.78        -2.93        -0.54        -0.31
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.93 kN-m.
           -. End Moments (My2) =        4.78 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.93 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.93 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.31 kN-m.
          -. End Moments (Mz2) =        0.54 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.31 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.31 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        26.485 kN-m.
          -. Mrz        =         2.752 kN-m.
          -. Mr         =        26.627 kN-m.
          -. Pu/Pr      =   0.111  --->  O.K !
          -. Muy/Mry    =   0.111  --->  O.K !
          -. Muz/Mrz    =   0.111  --->  O.K !
          -. Mu/Mr      =   0.111  --->  O.K !
          -. Ratio      =   0.111  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2306.28 kN.
          -. Vuz    =         12.88 kN.
          -. Muy    =        -10.10 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          4.57 kN.
          -. Muz    =         -3.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 12.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1756.43 kN.
-. phiVcz = phi * Vcz = 1580.79 kN.

-. Vuy = 4.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1729.05 kN.
-. phiVcy = phi * Vcy = 1556.14 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2334.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5392.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2334.22 kN.
-. phiVsz = phi*Vsz = 2100.80 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.68 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5419.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.68 kN.
-. phiVsy = phi*Vsy = 2093.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 13.671 kN.
-. Vr = 3649.249 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 15.19 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 15.19 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111243,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2716.10        -2.93        -1.42        -0.31        -0.14
           ------------------------------------------------------------------------------
            DL+LL+Others     2716.10        -2.93        -1.42        -0.31        -0.14
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.42 kN-m.
           -. End Moments (My2) =        2.93 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.14 kN-m.
          -. End Moments (Mz2) =        0.31 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.14 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.14 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        12.739 kN-m.
          -. Mrz        =         1.224 kN-m.
          -. Mr         =        12.798 kN-m.
          -. Pu/Pr      =   0.111  --->  O.K !
          -. Muy/Mry    =   0.111  --->  O.K !
          -. Muz/Mrz    =   0.112  --->  O.K !
          -. Mu/Mr      =   0.112  --->  O.K !
          -. Ratio      =   0.112  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2322.94 kN.
          -. Vuz    =         10.47 kN.
          -. Muy    =         -4.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          3.45 kN.
          -. Muz    =         -1.48 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 10.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1755.57 kN.
-. phiVcz = phi * Vcz = 1580.02 kN.

-. Vuy = 3.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.15 kN.
-. phiVcy = phi * Vcy = 1555.33 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2333.96 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5392.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2333.96 kN.
-. phiVsz = phi*Vsz = 2100.56 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5420.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.39 kN.
-. phiVsy = phi*Vsy = 2092.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 11.019 kN.
-. Vr = 3648.186 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 12.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 12.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111244,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2732.76        -1.42        -0.39        -0.14        -0.03
           ------------------------------------------------------------------------------
            DL+LL+Others     2732.76        -1.42        -0.39        -0.14        -0.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.39 kN-m.
           -. End Moments (My2) =        1.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.03 kN-m.
          -. End Moments (Mz2) =        0.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.03 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         3.498 kN-m.
          -. Mrz        =         0.307 kN-m.
          -. Mr         =         3.512 kN-m.
          -. Pu/Pr      =   0.112  --->  O.K !
          -. Muy/Mry    =   0.112  --->  O.K !
          -. Muz/Mrz    =   0.113  --->  O.K !
          -. Mu/Mr      =   0.113  --->  O.K !
          -. Ratio      =   0.113  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2339.59 kN.
          -. Vuz    =          7.06 kN.
          -. Muy    =         -1.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =          2.19 kN.
          -. Muz    =         -0.39 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.82
```

( ). Compute shear strength of concrete.
-. Vuz = 7.06 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1755.27 kN.
-. phiVcz = phi * Vcz = 1579.75 kN.

-. Vuy = 2.19 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1727.83 kN.
-. phiVcy = phi * Vcy = 1555.05 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2333.87 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5393.21 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2333.87 kN.
-. phiVsz = phi*Vsz = 2100.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.29 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5420.66 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.29 kN.
-. phiVsy = phi*Vsy = 2092.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 7.388 kN.
-. Vr = 3647.811 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 8.21 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 8.21 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =111245,  LCB = 148-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2732.76        -0.39         0.00        -0.03         0.00
           ---------------------------------------------------------------------------
            DL+LL+Others     2732.76        -0.39         0.00        -0.03         0.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.03 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         3.498 kN-m.
          -. Mrz        =         0.307 kN-m.
          -. Mr         =         3.512 kN-m.
          -. Pu/Pr      =   0.112  --->  O.K !
          -. Muy/Mry    =   0.112  --->  O.K !
          -. Muz/Mrz    =   0.113  --->  O.K !
          -. Mu/Mr      =   0.113  --->  O.K !
          -. Ratio      =   0.113  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2356.25 kN.
          -. Vuz    =          2.68 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.83

          -. Vuy    =          0.78 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.83
```

( ). Compute shear strength of concrete.
-. Vuz = 2.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1728.09 kN.
-. phiVcz = phi * Vcz = 1555.28 kN.

-. Vuy = 0.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1728.09 kN.
-. phiVcy = phi * Vcy = 1555.28 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2325.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5420.40 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2325.37 kN.
-. phiVsz = phi*Vsz = 2092.84 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2325.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5420.40 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2325.37 kN.
-. phiVsy = phi*Vsy = 2092.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 2.788 kN.
-. Vr = 3648.117 kN.
-. Ratio = Vu / Vr =7.644e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 3.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 3.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112102,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2338.19       184.54       308.22      1678.54       889.01
           ---------------------------------------------------------------------------
           DL+LL+Others    -2338.19       184.54       308.22      1678.54       889.01
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4906.910 kN.
          -. Mry        =       377.658 kN-m.
          -. Mrz        =      3525.639 kN-m.
          -. Mr         =      3545.809 kN-m.
          -. Pu/Pr      =   0.477  --->  O.K !
          -. Muy/Mry    =   0.489  --->  O.K !
          -. Muz/Mrz    =   0.476  --->  O.K !
          -. Mu/Mr      =   0.489  --->  O.K !
          -. Ratio      =   0.489  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5310.71 kN.
          -. Vuz    =        606.67 kN.
          -. Muy    =       -314.01 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.54 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.19
```

```
          -. Vuy    =       1542.66 kN.
          -. Muz    =       -621.10 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.10

     ( ). Compute shear strength of concrete.
          -. Vuz       =      606.67 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      991.67 kN.
          -. phiVcz    = phi * Vcz =      892.50 kN.

          -. Vuy       =     1542.66 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      948.76 kN.
          -. phiVcy    = phi * Vcy =      853.88 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1965.56 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6156.82 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1965.56 kN.
          -. phiVsz   = phi*Vsz =     1769.00 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1932.05 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6199.73 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1932.05 kN.
          -. phiVsy   = phi*Vsy =     1738.84 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1657.660 kN.
          -. Vr       =    2592.725 kN.
          -. Ratio    = Vu / Vr = 0.639  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1841.84 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1841.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112103,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2326.50       308.22       535.38       889.01       346.41
           ---------------------------------------------------------------------------
           DL+LL+Others    -2326.50       308.22       535.38       889.01       346.41
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6960.553 kN.
          -. Mry        =       930.461 kN-m.
          -. Mrz        =      2670.062 kN-m.
          -. Mr         =      2827.541 kN-m.
          -. Pu/Pr      =   0.334  --->  O.K !
          -. Muy/Mry    =   0.331  --->  O.K !
          -. Muz/Mrz    =   0.333  --->  O.K !
          -. Mu/Mr      =   0.334  --->  O.K !
          -. Ratio      =   0.334  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5327.66 kN.
          -. Vuz    =        528.73 kN.
          -. Muy    =       -551.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.27
```

-. Vuy = 1369.42 kN.
-. Muz = -106.22 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.63 Deg. [Clause 5.8.3.4.2]
-. betay = 2.18

( ). Compute shear strength of concrete.
-. Vuz = 528.73 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1026.27 kN.
-. phiVcz = phi * Vcz = 923.64 kN.

-. Vuy = 1369.42 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 983.11 kN.
-. phiVcy = phi * Vcy = 884.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1991.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6122.22 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1991.06 kN.
-. phiVsz = phi*Vsz = 1791.95 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1959.05 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6165.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1959.05 kN.
-. phiVsy = phi*Vsy = 1763.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1467.945 kN.
-. Vr = 2647.951 kN.
-. Ratio = Vu / Vr = 0.554 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1631.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1631.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112104,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2302.80       535.38       736.36       346.41       856.94
           ---------------------------------------------------------------------------
           DL+LL+Others    -2302.80       535.38       736.36       346.41       856.94
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6273.944 kN.
          -. Mry        =      2003.028 kN-m.
          -. Mrz        =      2342.205 kN-m.
          -. Mr         =      3081.890 kN-m.
          -. Pu/Pr      =   0.367  --->  O.K !
          -. Muy/Mry    =   0.368  --->  O.K !
          -. Muz/Mrz    =   0.366  --->  O.K !
          -. Mu/Mr      =   0.368  --->  O.K !
          -. Ratio      =   0.368  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5344.60 kN.
          -. Vuz    =        451.50 kN.
          -. Muy    =       -762.09 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

-. Vuy = 1196.00 kN.
-. Muz = -644.06 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.25 Deg. [Clause 5.8.3.4.2]
-. betay = 2.26

( ). Compute shear strength of concrete.
-. Vuz = 451.50 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1063.34 kN.
-. phiVcz = phi * Vcz = 957.01 kN.

-. Vuy = 1196.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1020.02 kN.
-. phiVcy = phi * Vcy = 918.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2016.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6085.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2016.99 kN.
-. phiVsz = phi*Vsz = 1815.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1986.55 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6128.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1986.55 kN.
-. phiVsy = phi*Vsy = 1787.89 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1278.390 kN.
-. Vr = 2705.912 kN.
-. Ratio = Vu / Vr = 0.472 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1420.43 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1420.43 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112105,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2291.09       736.36       905.13       856.94      1321.03
           ---------------------------------------------------------------------------
           DL+LL+Others    -2291.09       736.36       905.13       856.94      1321.03
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5002.617 kN.
          -. Mry        =      1975.707 kN-m.
          -. Mrz        =      2908.832 kN-m.
          -. Mr         =      3516.350 kN-m.
          -. Pu/Pr      =   0.458  --->  O.K !
          -. Muy/Mry    =   0.458  --->  O.K !
          -. Muz/Mrz    =   0.454  --->  O.K !
          -. Mu/Mr      =   0.458  --->  O.K !
          -. Ratio      =   0.458  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5361.54 kN.
          -. Vuz    =        375.79 kN.
          -. Muy    =       -938.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.30
```

-. Vuy = 1024.28 kN.
-. Muz = -1134.84 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.50 Deg. [Clause 5.8.3.4.2]
-. betay = 2.20

( ). Compute shear strength of concrete.
-. Vuz = 375.79 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1038.33 kN.
-. phiVcz = phi * Vcz = 934.50 kN.

-. Vuy = 1024.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 995.11 kN.
-. phiVcy = phi * Vcy = 895.60 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1999.64 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6110.16 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1999.64 kN.
-. phiVsz = phi*Vsz = 1799.68 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1968.15 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6153.38 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1968.15 kN.
-. phiVsy = phi*Vsy = 1771.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1091.041 kN.
-. Vr = 2666.938 kN.
-. Ratio = Vu / Vr = 0.409 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1212.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1212.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112106,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2279.37       905.13      1039.90      1321.03      1720.00
           ---------------------------------------------------------------------------
           DL+LL+Others    -2279.37       905.13      1039.90      1321.03      1720.00
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4269.711 kN.
          -. Mry        =      1933.406 kN-m.
          -. Mrz        =      3215.107 kN-m.
          -. Mr         =      3751.662 kN-m.
          -. Pu/Pr      =   0.534  --->  O.K !
          -. Muy/Mry    =   0.538  --->  O.K !
          -. Muz/Mrz    =   0.535  --->  O.K !
          -. Mu/Mr      =   0.538  --->  O.K !
          -. Ratio      =   0.538  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5378.46 kN.
          -. Vuz    =        302.41 kN.
          -. Muy    =      -1079.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

-. Vuy = 856.15 kN.
-. Muz = -1559.63 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.82 Deg. [Clause 5.8.3.4.2]
-. betay = 2.14

( ). Compute shear strength of concrete.
-. Vuz = 302.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1007.99 kN.
-. phiVcz = phi * Vcz = 907.19 kN.

-. Vuy = 856.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 964.95 kN.
-. phiVcy = phi * Vcy = 868.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1977.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6140.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1977.75 kN.
-. phiVsz = phi*Vsz = 1779.97 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1944.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6183.53 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1944.96 kN.
-. phiVsy = phi*Vsy = 1750.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 907.986 kN.
-. Vr = 2618.918 kN.
-. Ratio = Vu / Vr = 0.347 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1008.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1008.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112107,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2267.64      1039.90      1142.18      1720.00      2047.92
           ---------------------------------------------------------------------------
           DL+LL+Others    -2267.64      1039.90      1142.18      1720.00      2047.92
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3755.959 kN.
          -. Mry        =      1894.155 kN-m.
          -. Mrz        =      3421.964 kN-m.
          -. Mr         =      3911.222 kN-m.
          -. Pu/Pr      =   0.604  --->  O.K !
          -. Muy/Mry    =   0.603  --->  O.K !
          -. Muz/Mrz    =   0.598  --->  O.K !
          -. Mu/Mr      =   0.604  --->  O.K !
          -. Ratio      =   0.604  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5395.38 kN.
          -. Vuz    =        232.17 kN.
          -. Muy    =      -1186.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
```

```
          -. Vuy    =       693.47 kN.
          -. Muz    =     -1912.29 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.09

     ( ). Compute shear strength of concrete.
          -. Vuz       =     232.17 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     986.02 kN.
          -. phiVcz    = phi * Vcz =     887.42 kN.

          -. Vuy       =     693.47 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     943.16 kN.
          -. phiVcy    = phi * Vcy =     848.84 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1961.27 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6162.47 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1961.27 kN.
          -. phiVsz   = phi*Vsz =     1765.14 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1927.51 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6205.33 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1927.51 kN.
          -. phiVsy   = phi*Vsy =     1734.76 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     731.308 kN.
          -. Vr       =    2583.604 kN.
          -. Ratio    = Vu / Vr = 0.283  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 812.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 812.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112108,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2255.90      1142.18      1221.76      2047.92      2302.99
           ---------------------------------------------------------------------------
           DL+LL+Others    -2255.90      1142.18      1221.76      2047.92      2302.99
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3471.457 kN.
          -. Mry        =      1866.583 kN-m.
          -. Mrz        =      3537.936 kN-m.
          -. Mr         =      4000.140 kN-m.
          -. Pu/Pr      =   0.650  --->  O.K !
          -. Muy/Mry    =   0.655  --->  O.K !
          -. Muz/Mrz    =   0.651  --->  O.K !
          -. Mu/Mr      =   0.655  --->  O.K !
          -. Ratio      =   0.655  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5412.30 kN.
          -. Vuz    =        165.88 kN.
          -. Muy    =      -1269.40 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.75 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.15
```

```
          -. Vuy    =       538.14 kN.
          -. Muz    =     -2190.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.06

     ( ). Compute shear strength of concrete.
          -. Vuz       =     165.88 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      971.43 kN.
          -. phiVcz    = phi * Vcz =      874.28 kN.

          -. Vuy       =     538.14 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      928.70 kN.
          -. phiVcy    = phi * Vcy =      835.83 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1950.02 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6177.06 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1950.02 kN.
          -. phiVsz   = phi*Vsz =     1755.02 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1915.61 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6219.78 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1915.61 kN.
          -. phiVsy   = phi*Vsy =     1724.05 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     563.126 kN.
          -. Vr       =    2559.884 kN.
          -. Ratio    = Vu / Vr = 0.220  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 625.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 625.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112109,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2244.16      1221.76      1271.06      2302.99      2487.35
           ---------------------------------------------------------------------------
           DL+LL+Others    -2244.16      1221.76      1271.06      2302.99      2487.35
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3286.483 kN.
          -. Mry        =      1842.523 kN-m.
          -. Mrz        =      3615.907 kN-m.
          -. Mr         =      4058.284 kN-m.
          -. Pu/Pr      =   0.683  --->  O.K !
          -. Muy/Mry    =   0.690  --->  O.K !
          -. Muz/Mrz    =   0.688  --->  O.K !
          -. Mu/Mr      =   0.690  --->  O.K !
          -. Ratio      =   0.690  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5429.20 kN.
          -. Vuz    =        104.36 kN.
          -. Muy    =      -1320.83 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.13
```

```
          -. Vuy    =       391.95 kN.
          -. Muz    =     -2397.31 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.32 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.04

     ( ). Compute shear strength of concrete.
          -. Vuz       =     104.36 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      963.85 kN.
          -. phiVcz    = phi * Vcz =      867.47 kN.

          -. Vuy       =     391.95 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      921.21 kN.
          -. phiVcy    = phi * Vcy =      829.08 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1944.09 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6184.63 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1944.09 kN.
          -. phiVsz   = phi*Vsz =     1749.68 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1909.33 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6227.28 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1909.33 kN.
          -. phiVsy   = phi*Vsy =     1718.40 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     405.603 kN.
          -. Vr       =    2547.484 kN.
          -. Ratio    = Vu / Vr = 0.159  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 450.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 450.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112110,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2232.41      1271.06      1292.35      2487.35      2605.35
           ---------------------------------------------------------------------------
           DL+LL+Others    -2232.41      1271.06      1292.35      2487.35      2605.35
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3155.374 kN.
          -. Mry        =      1821.534 kN-m.
          -. Mrz        =      3672.830 kN-m.
          -. Mr         =      4099.715 kN-m.
          -. Pu/Pr      =   0.707  --->  O.K !
          -. Muy/Mry    =   0.709  --->  O.K !
          -. Muz/Mrz    =   0.709  --->  O.K !
          -. Mu/Mr      =   0.709  --->  O.K !
          -. Ratio      =   0.709  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5446.10 kN.
          -. Vuz    =         48.99 kN.
          -. Muy    =      -1343.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.13
```

```
          -. Vuy    =       257.01 kN.
          -. Muz    =     -2535.88 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.04

     ( ). Compute shear strength of concrete.
          -. Vuz       =       48.99 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      962.33 kN.
          -. phiVcz    = phi * Vcz =      866.10 kN.

          -. Vuy       =      257.01 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      919.70 kN.
          -. phiVcy    = phi * Vcy =      827.73 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1942.89 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6186.15 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1942.89 kN.
          -. phiVsz   = phi*Vsz =     1748.60 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1908.07 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6228.78 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1908.07 kN.
          -. phiVsy   = phi*Vsy =     1717.26 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     261.636 kN.
          -. Vr       =    2544.992 kN.
          -. Ratio    = Vu / Vr = 0.103  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 290.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 290.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112111,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2220.65      1292.35      1288.44      2605.35      2662.62
           ---------------------------------------------------------------------------
           DL+LL+Others    -2220.65      1292.35      1288.44      2605.35      2662.62
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3113.294 kN.
          -. Mry        =      1794.894 kN-m.
          -. Mrz        =      3697.176 kN-m.
          -. Mr         =      4109.836 kN-m.
          -. Pu/Pr      =   0.713  --->  O.K !
          -. Muy/Mry    =   0.718  --->  O.K !
          -. Muz/Mrz    =   0.720  --->  O.K !
          -. Mu/Mr      =   0.720  --->  O.K !
          -. Ratio      =   0.720  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5462.99 kN.
          -. Vuz    =         26.94 kN.
          -. Muy    =      -1339.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.81 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.14
```

```
          -. Vuy    =       134.53 kN.
          -. Muz    =     -2612.09 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.30 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.04

     ( ). Compute shear strength of concrete.
          -. Vuz       =      26.94 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      965.73 kN.
          -. phiVcz    = phi * Vcz =      869.16 kN.

          -. Vuy       =     134.53 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      923.06 kN.
          -. phiVcy    = phi * Vcy =      830.76 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1945.57 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6182.76 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1945.57 kN.
          -. phiVsz   = phi*Vsz =     1751.01 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1910.90 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6225.42 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1910.90 kN.
          -. phiVsy   = phi*Vsy =     1719.81 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     137.198 kN.
          -. Vr       =    2550.565 kN.
          -. Ratio    = Vu / Vr = 0.054  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 152.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 152.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112112,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2220.88      1288.44      1262.71      2662.62      2665.61
           ---------------------------------------------------------------------------
           DL+LL+Others    -2220.88      1288.44      1262.71      2662.62      2665.61
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3113.294 kN.
          -. Mry        =      1794.894 kN-m.
          -. Mrz        =      3697.176 kN-m.
          -. Mr         =      4109.836 kN-m.
          -. Pu/Pr      =   0.713  --->  O.K !
          -. Muy/Mry    =   0.718  --->  O.K !
          -. Muz/Mrz    =   0.720  --->  O.K !
          -. Mu/Mr      =   0.720  --->  O.K !
          -. Ratio      =   0.720  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4287.70 kN.
          -. Vuz    =        100.10 kN.
          -. Muy    =      -2008.08 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42
```

```
          -. Vuy    =         43.16 kN.
          -. Muz    =      -1193.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.98 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.32

     ( ). Compute shear strength of concrete.
          -. Vuz       =      100.10 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1092.35 kN.
          -. phiVcz    = phi * Vcz =      983.12 kN.

          -. Vuy       =       43.16 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1048.97 kN.
          -. phiVcy    = phi * Vcy =      944.08 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2036.35 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6056.13 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2036.35 kN.
          -. phiVsz   = phi*Vsz =     1832.71 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2007.10 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6099.51 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2007.10 kN.
          -. phiVsy   = phi*Vsy =     1806.39 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     109.010 kN.
          -. Vr       =    2750.465 kN.
          -. Ratio    = Vu / Vr = 0.040  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 121.12 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 121.12 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112113,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2209.10      1262.71      1218.48      2665.61      2621.43
           ---------------------------------------------------------------------------
           DL+LL+Others    -2209.10      1262.71      1218.48      2665.61      2621.43
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3074.350 kN.
          -. Mry        =      1765.076 kN-m.
          -. Mrz        =      3723.303 kN-m.
          -. Mr         =      4120.495 kN-m.
          -. Pu/Pr      =   0.719  --->  O.K !
          -. Muy/Mry    =   0.715  --->  O.K !
          -. Muz/Mrz    =   0.716  --->  O.K !
          -. Mu/Mr      =   0.719  --->  O.K !
          -. Ratio      =   0.719  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4304.53 kN.
          -. Vuz    =        154.09 kN.
          -. Muy    =      -1963.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.41
```

```
          -. Vuy    =         46.65 kN.
          -. Muz    =      -1214.96 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.31

     ( ). Compute shear strength of concrete.
          -. Vuz       =      154.09 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1089.22 kN.
          -. phiVcz    = phi * Vcz =      980.30 kN.

          -. Vuy       =       46.65 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1045.85 kN.
          -. phiVcy    = phi * Vcy =      941.26 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2034.30 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6059.26 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2034.30 kN.
          -. phiVsz   = phi*Vsz =     1830.87 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2004.92 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6102.64 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2004.92 kN.
          -. phiVsy   = phi*Vsy =     1804.43 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     160.999 kN.
          -. Vr       =    2745.691 kN.
          -. Ratio    = Vu / Vr = 0.059  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 178.89 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 178.89 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112114,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2197.32      1218.48      1153.48      2621.43      2523.49
           ---------------------------------------------------------------------------
           DL+LL+Others    -2197.32      1218.48      1153.48      2621.43      2523.49
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3112.827 kN.
          -. Mry        =      1730.259 kN-m.
          -. Mrz        =      3727.862 kN-m.
          -. Mr         =      4109.836 kN-m.
          -. Pu/Pr      =   0.706  --->  O.K !
          -. Muy/Mry    =   0.704  --->  O.K !
          -. Muz/Mrz    =   0.703  --->  O.K !
          -. Mu/Mr      =   0.706  --->  O.K !
          -. Ratio      =   0.706  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5496.96 kN.
          -. Vuz    =        139.92 kN.
          -. Muy    =      -1266.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.13
```

```
          -. Vuy    =       174.96 kN.
          -. Muz    =     -2603.76 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.03

     ( ). Compute shear strength of concrete.
          -. Vuz       =     139.92 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      960.83 kN.
          -. phiVcz    = phi * Vcz =      864.74 kN.

          -. Vuy       =     174.96 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      918.21 kN.
          -. phiVcy    = phi * Vcy =      826.39 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1941.70 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6187.66 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1941.70 kN.
          -. phiVsz   = phi*Vsz =     1747.53 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1906.81 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6230.27 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1906.81 kN.
          -. phiVsy   = phi*Vsy =     1716.12 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     224.030 kN.
          -. Vr       =    2542.516 kN.
          -. Ratio    = Vu / Vr = 0.088  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 248.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 248.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112115,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2185.54      1153.48      1068.68      2523.49      2373.88
           ---------------------------------------------------------------------------
           DL+LL+Others    -2185.54      1153.48      1068.68      2523.49      2373.88
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3235.211 kN.
          -. Mry        =      1698.173 kN-m.
          -. Mrz        =      3707.534 kN-m.
          -. Mr         =      4077.941 kN-m.
          -. Pu/Pr      =   0.676  --->  O.K !
          -. Muy/Mry    =   0.679  --->  O.K !
          -. Muz/Mrz    =   0.681  --->  O.K !
          -. Mu/Mr      =   0.681  --->  O.K !
          -. Ratio      =   0.681  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5513.82 kN.
          -. Vuz    =        178.19 kN.
          -. Muy    =      -1199.09 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.13
```

```
          -. Vuy    =       283.43 kN.
          -. Muz    =     -2519.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.03

     ( ). Compute shear strength of concrete.
          -. Vuz       =     178.19 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     961.08 kN.
          -. phiVcz    = phi * Vcz =     864.97 kN.

          -. Vuy       =     283.43 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     918.46 kN.
          -. phiVcy    = phi * Vcy =     826.62 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1941.90 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6187.41 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1941.90 kN.
          -. phiVsz   = phi*Vsz =     1747.71 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1907.02 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6230.03 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1907.02 kN.
          -. phiVsy   = phi*Vsy =     1716.31 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     334.792 kN.
          -. Vr       =    2542.930 kN.
          -. Ratio    = Vu / Vr = 0.132  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 371.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 371.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112116,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2173.74      1068.68       969.84      2373.88      2184.74
           ---------------------------------------------------------------------------
           DL+LL+Others    -2173.74      1068.68       969.84      2373.88      2184.74
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3354.137 kN.
          -. Mry        =      1665.831 kN-m.
          -. Mrz        =      3681.908 kN-m.
          -. Mr         =      4041.218 kN-m.
          -. Pu/Pr      =   0.648  --->  O.K !
          -. Muy/Mry    =   0.642  --->  O.K !
          -. Muz/Mrz    =   0.645  --->  O.K !
          -. Mu/Mr      =   0.648  --->  O.K !
          -. Ratio      =   0.648  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5530.67 kN.
          -. Vuz    =        206.66 kN.
          -. Muy    =      -1110.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.77 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.15
```

-. Vuy = 365.69 kN.
-. Muz = -2380.12 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 35.26 Deg. [Clause 5.8.3.4.2]
-. betay = 2.05

( ). Compute shear strength of concrete.
-. Vuz = 206.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 969.22 kN.
-. phiVcz = phi * Vcz = 872.30 kN.

-. Vuy = 365.69 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 926.52 kN.
-. phiVcy = phi * Vcy = 833.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1948.30 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6179.27 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1948.30 kN.
-. phiVsz = phi*Vsz = 1753.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1913.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6221.97 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1913.79 kN.
-. phiVsy = phi*Vsy = 1722.41 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 420.047 kN.
-. Vr = 2556.276 kN.
-. Ratio = Vu / Vr = 0.164 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 466.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 466.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =5.0472e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =6.4863e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =6.4863e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112117,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2161.94       969.84       862.58      2184.74      1969.24
           ---------------------------------------------------------------------------
           DL+LL+Others    -2161.94       969.84       862.58      2184.74      1969.24
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3585.008 kN.
          -. Mry        =      1618.404 kN-m.
          -. Mrz        =      3627.499 kN-m.
          -. Mr         =      3972.150 kN-m.
          -. Pu/Pr      =   0.603  --->  O.K !
          -. Muy/Mry    =   0.599  --->  O.K !
          -. Muz/Mrz    =   0.602  --->  O.K !
          -. Mu/Mr      =   0.603  --->  O.K !
          -. Ratio      =   0.603  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5547.51 kN.
          -. Vuz    =        223.74 kN.
          -. Muy    =      -1008.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.61 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
```

```
          -. Vuy    =       421.78 kN.
          -. Muz    =     -2199.10 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.08

     ( ). Compute shear strength of concrete.
          -. Vuz       =      223.74 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      984.46 kN.
          -. phiVcz    = phi * Vcz =      886.01 kN.

          -. Vuy       =      421.78 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      941.61 kN.
          -. phiVcy    = phi * Vcy =      847.45 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1960.08 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6164.03 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1960.08 kN.
          -. phiVsz   = phi*Vsz =     1764.07 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1926.25 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6206.87 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1926.25 kN.
          -. phiVsy   = phi*Vsy =     1733.63 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     477.445 kN.
          -. Vr       =    2581.079 kN.
          -. Ratio    = Vu / Vr = 0.185  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 530.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 530.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112118,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2150.13       862.58       751.91      1969.24      1740.01
           ---------------------------------------------------------------------------
           DL+LL+Others    -2150.13       862.58       751.91      1969.24      1740.01
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3896.406 kN.
          -. Mry        =      1559.014 kN-m.
          -. Mrz        =      3543.655 kN-m.
          -. Mr         =      3871.436 kN-m.
          -. Pu/Pr      =   0.552  --->  O.K !
          -. Muy/Mry    =   0.553  --->  O.K !
          -. Muz/Mrz    =   0.556  --->  O.K !
          -. Mu/Mr      =   0.556  --->  O.K !
          -. Ratio      =   0.556  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5564.35 kN.
          -. Vuz    =        230.44 kN.
          -. Muy    =       -896.71 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

```
          -. Vuy    =       453.65 kN.
          -. Muz    =     -1989.46 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.13

     ( ). Compute shear strength of concrete.
          -. Vuz       =     230.44 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1005.74 kN.
          -. phiVcz    = phi * Vcz =      905.17 kN.

          -. Vuy       =     453.65 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      962.72 kN.
          -. phiVcy    = phi * Vcy =      866.45 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1976.09 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6142.75 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1976.09 kN.
          -. phiVsz   = phi*Vsz =     1778.48 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1943.20 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6185.76 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1943.20 kN.
          -. phiVsy   = phi*Vsy =     1748.88 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     508.819 kN.
          -. Vr       =    2615.327 kN.
          -. Ratio    = Vu / Vr = 0.195  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 565.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 565.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112119,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2138.31       751.91       642.22      1740.01      1507.06
           ---------------------------------------------------------------------------
           DL+LL+Others    -2138.31       751.91       642.22      1740.01      1507.06
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4216.321 kN.
          -. Mry        =      1497.982 kN-m.
          -. Mrz        =      3456.788 kN-m.
          -. Mr         =      3767.404 kN-m.
          -. Pu/Pr      =   0.507  --->  O.K !
          -. Muy/Mry    =   0.502  --->  O.K !
          -. Muz/Mrz    =   0.503  --->  O.K !
          -. Mu/Mr      =   0.507  --->  O.K !
          -. Ratio      =   0.507  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5581.18 kN.
          -. Vuz    =        228.24 kN.
          -. Muy    =       -781.67 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.14 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =       463.97 kN.
          -. Muz    =     -1764.11 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.57 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.19

     ( ). Compute shear strength of concrete.
          -. Vuz       =     228.24 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1031.98 kN.
          -. phiVcz    = phi * Vcz =      928.78 kN.

          -. Vuy       =     463.97 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      988.79 kN.
          -. phiVcy    = phi * Vcy =      889.91 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1995.14 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6116.51 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1995.14 kN.
          -. phiVsz   = phi*Vsz =     1795.63 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1963.38 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6159.70 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1963.38 kN.
          -. phiVsy   = phi*Vsy =     1767.04 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     517.066 kN.
          -. Vr       =    2656.955 kN.
          -. Ratio    = Vu / Vr = 0.195  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 574.52 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 574.52 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112120,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2126.48       642.22       537.16      1507.06      1279.14
           ---------------------------------------------------------------------------
           DL+LL+Others    -2126.48       642.22       537.16      1507.06      1279.14
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4713.015 kN.
          -. Mry        =      1411.199 kN-m.
          -. Mrz        =      3317.090 kN-m.
          -. Mr         =      3604.798 kN-m.
          -. Pu/Pr      =   0.451  --->  O.K !
          -. Muy/Mry    =   0.455  --->  O.K !
          -. Muz/Mrz    =   0.454  --->  O.K !
          -. Mu/Mr      =   0.455  --->  O.K !
          -. Ratio      =   0.455  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5598.00 kN.
          -. Vuz    =        218.47 kN.
          -. Muy    =       -667.64 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

-. Vuy = 455.74 kN.
-. Muz = -1533.35 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.27 Deg. [Clause 5.8.3.4.2]
-. betay = 2.26

( ). Compute shear strength of concrete.
-. Vuz = 218.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1062.21 kN.
-. phiVcz = phi * Vcz = 955.99 kN.

-. Vuy = 455.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1018.89 kN.
-. phiVcy = phi * Vcy = 917.00 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2016.21 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6086.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2016.21 kN.
-. phiVsz = phi*Vsz = 1814.59 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1985.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6129.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1985.73 kN.
-. phiVsy = phi*Vsy = 1787.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 505.401 kN.
-. Vr = 2704.156 kN.
-. Ratio = Vu / Vr = 0.187 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 561.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 561.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112121,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2114.65       537.16       439.72      1279.14      1063.79
           ---------------------------------------------------------------------------
           DL+LL+Others    -2114.65       537.16       439.72      1279.14      1063.79
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5233.251 kN.
          -. Mry        =      1319.524 kN-m.
          -. Mrz        =      3169.844 kN-m.
          -. Mr         =      3433.520 kN-m.
          -. Pu/Pr      =   0.404  --->  O.K !
          -. Muy/Mry    =   0.407  --->  O.K !
          -. Muz/Mrz    =   0.404  --->  O.K !
          -. Mu/Mr      =   0.407  --->  O.K !
          -. Ratio      =   0.407  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5614.82 kN.
          -. Vuz    =        202.64 kN.
          -. Muy    =       -558.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.57 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42
```

-. Vuy = 432.27 kN.
-. Muz = -1306.19 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.95 Deg. [Clause 5.8.3.4.2]
-. betay = 2.33

( ). Compute shear strength of concrete.
-. Vuz = 202.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1095.38 kN.
-. phiVcz = phi * Vcz = 985.84 kN.

-. Vuy = 432.27 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1052.00 kN.
-. phiVcy = phi * Vcy = 946.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2038.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6053.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2038.33 kN.
-. phiVsz = phi*Vsz = 1834.49 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2009.20 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6096.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2009.20 kN.
-. phiVsy = phi*Vsy = 1808.28 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 477.404 kN.
-. Vr = 2755.077 kN.
-. Ratio = Vu / Vr = 0.173 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 530.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 530.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112122,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2102.81       439.72       352.20      1063.79       867.06
           ---------------------------------------------------------------------------
           DL+LL+Others    -2102.81       439.72       352.20      1063.79       867.06
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5893.850 kN.
          -. Mry        =      1224.294 kN-m.
          -. Mrz        =      2967.330 kN-m.
          -. Mr         =      3209.976 kN-m.
          -. Pu/Pr      =   0.357  --->  O.K !
          -. Muy/Mry    =   0.359  --->  O.K !
          -. Muz/Mrz    =   0.359  --->  O.K !
          -. Mu/Mr      =   0.359  --->  O.K !
          -. Ratio      =   0.359  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5631.62 kN.
          -. Vuz    =        182.00 kN.
          -. Muy    =       -457.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.50
```

-. Vuy = 396.39 kN.
-. Muz = -1090.48 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.64 Deg. [Clause 5.8.3.4.2]
-. betay = 2.41

( ). Compute shear strength of concrete.
-. Vuz = 182.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1130.39 kN.
-. phiVcz = phi * Vcz = 1017.35 kN.

-. Vuy = 396.39 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1087.02 kN.
-. phiVcy = phi * Vcy = 978.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2060.59 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6018.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2060.59 kN.
-. phiVsz = phi*Vsz = 1854.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2032.85 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6061.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2032.85 kN.
-. phiVsy = phi*Vsy = 1829.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 436.173 kN.
-. Vr = 2807.886 kN.
-. Ratio = Vu / Vr = 0.155 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 484.64 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 484.64 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112123,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2090.96       352.20       276.29       867.06       693.55
           ---------------------------------------------------------------------------
           DL+LL+Others    -2090.96       352.20       276.29       867.06       693.55
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6607.746 kN.
          -. Mry        =      1126.610 kN-m.
          -. Mrz        =      2735.296 kN-m.
          -. Mr         =      2958.225 kN-m.
          -. Pu/Pr      =   0.316  --->  O.K !
          -. Muy/Mry    =   0.313  --->  O.K !
          -. Muz/Mrz    =   0.317  --->  O.K !
          -. Mu/Mr      =   0.317  --->  O.K !
          -. Ratio      =   0.317  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5648.42 kN.
          -. Vuz    =        157.86 kN.
          -. Muy    =       -366.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.58
```

```
          -. Vuy    =       350.89 kN.
          -. Muz    =      -892.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.49

     ( ). Compute shear strength of concrete.
          -. Vuz       =     157.86 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1166.03 kN.
          -. phiVcz    = phi * Vcz =     1049.43 kN.

          -. Vuy       =     350.89 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1122.77 kN.
          -. phiVcy    = phi * Vcy =     1010.50 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2082.19 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5982.46 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2082.19 kN.
          -. phiVsz   = phi*Vsz =     1873.97 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2055.83 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6025.71 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2055.83 kN.
          -. phiVsy   = phi*Vsy =     1850.25 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     384.762 kN.
          -. Vr       =    2860.746 kN.
          -. Ratio    = Vu / Vr = 0.134  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 427.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 427.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0053 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0053 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112124,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2079.10       276.29       213.12       693.55       546.54
           ---------------------------------------------------------------------------
           DL+LL+Others    -2079.10       276.29       213.12       693.55       546.54
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7414.554 kN.
          -. Mry        =       982.354 kN-m.
          -. Mrz        =      2468.510 kN-m.
          -. Mr         =      2656.796 kN-m.
          -. Pu/Pr      =   0.280  --->  O.K !
          -. Muy/Mry    =   0.281  --->  O.K !
          -. Muz/Mrz    =   0.281  --->  O.K !
          -. Mu/Mr      =   0.281  --->  O.K !
          -. Ratio      =   0.281  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5665.21 kN.
          -. Vuz    =        131.38 kN.
          -. Muy    =       -287.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.66
```

```
          -. Vuy    =       298.61 kN.
          -. Muz    =      -717.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.07 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56

     ( ). Compute shear strength of concrete.
          -. Vuz       =     131.38 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1201.01 kN.
          -. phiVcz    = phi * Vcz =     1080.91 kN.

          -. Vuy       =     298.61 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1157.96 kN.
          -. phiVcy    = phi * Vcy =     1042.16 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2102.44 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5947.47 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2102.44 kN.
          -. phiVsz   = phi*Vsz =     1892.20 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2077.39 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5990.53 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2077.39 kN.
          -. phiVsy   = phi*Vsy =     1869.65 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     326.236 kN.
          -. Vr       =    2911.815 kN.
          -. Ratio    = Vu / Vr = 0.112  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 362.48 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 362.48 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0061 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0060 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0060 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112125,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2067.24       213.12       158.99       546.54       418.89
           ---------------------------------------------------------------------------
           DL+LL+Others    -2067.24       213.12       158.99       546.54       418.89
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -8208.896 kN.
          -. Mry        =       847.012 kN-m.
          -. Mrz        =      2195.278 kN-m.
          -. Mr         =      2353.014 kN-m.
          -. Pu/Pr      =   0.252  --->  O.K !
          -. Muy/Mry    =   0.252  --->  O.K !
          -. Muz/Mrz    =   0.249  --->  O.K !
          -. Mu/Mr      =   0.252  --->  O.K !
          -. Ratio      =   0.252  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5682.00 kN.
          -. Vuz    =        112.57 kN.
          -. Muy    =       -221.55 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73
```

```
          -. Vuy    =       260.18 kN.
          -. Muz    =      -567.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.63

     ( ). Compute shear strength of concrete.
          -. Vuz       =     112.57 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1231.23 kN.
          -. phiVcz    = phi * Vcz =     1108.11 kN.

          -. Vuy       =     260.18 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1188.43 kN.
          -. phiVcy    = phi * Vcy =     1069.58 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2119.21 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5917.25 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2119.21 kN.
          -. phiVsz   = phi*Vsz =     1907.29 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2095.26 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5960.06 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2095.26 kN.
          -. phiVsy   = phi*Vsy =     1885.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     283.491 kN.
          -. Vr       =    2955.320 kN.
          -. Ratio    = Vu / Vr = 0.096  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 314.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 314.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0067 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0067 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0067 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112126,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5715.43      -165.28      -117.43      -437.85      -325.49
           ------------------------------------------------------------------------------
            DL+LL+Others     5715.43      -165.28      -117.43      -437.85      -325.49
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      117.43 kN-m.
           -. End Moments (My2) =      165.28 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -117.43 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -117.43 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      325.49 kN-m.
          -. End Moments (Mz2) =      437.85 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -325.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -325.49 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       501.146 kN-m.
          -. Mrz        =      1389.947 kN-m.
          -. Mr         =      1477.532 kN-m.
          -. Pu/Pr      =   0.234  --->  O.K !
          -. Muy/Mry    =   0.234  --->  O.K !
          -. Muz/Mrz    =   0.234  --->  O.K !
          -. Mu/Mr      =   0.234  --->  O.K !
          -. Ratio      =   0.234  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5698.78 kN.
          -. Vuz    =         95.74 kN.
          -. Muy    =       -165.28 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.79

          -. Vuy    =        224.81 kN.
          -. Muz    =       -437.85 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.65 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69
```

( ). Compute shear strength of concrete.
-. Vuz = 95.74 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1258.88 kN.
-. phiVcz = phi * Vcz = 1133.00 kN.

-. Vuy = 224.81 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1216.36 kN.
-. phiVcy = phi * Vcy = 1094.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2134.01 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5889.60 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2134.01 kN.
-. phiVsz = phi*Vsz = 1920.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2111.04 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5932.12 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2111.04 kN.
-. phiVsy = phi*Vsy = 1899.94 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 244.346 kN.
-. Vr = 2994.662 kN.
-. Ratio = Vu / Vr = 0.082 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 271.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 271.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0072 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0072 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0072 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112127,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5732.20      -117.43       -77.72      -325.49      -230.61
           ---------------------------------------------------------------------------
            DL+LL+Others     5732.20      -117.43       -77.72      -325.49      -230.61
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       77.72 kN-m.
           -. End Moments (My2) =      117.43 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -77.72 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -77.72 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      230.61 kN-m.
          -. End Moments (Mz2) =      325.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -230.61 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -230.61 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       330.790 kN-m.
          -. Mrz        =       981.853 kN-m.
          -. Mr         =      1036.077 kN-m.
          -. Pu/Pr      =   0.235  --->  O.K !
          -. Muy/Mry    =   0.235  --->  O.K !
          -. Muz/Mrz    =   0.235  --->  O.K !
          -. Mu/Mr      =   0.235  --->  O.K !
          -. Ratio      =   0.235  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5715.54 kN.
          -. Vuz    =         79.47 kN.
          -. Muy    =       -117.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        189.89 kN.
          -. Muz    =       -325.49 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 79.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1284.27 kN.
-. phiVcz = phi * Vcz = 1155.84 kN.

-. Vuy = 189.89 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1242.06 kN.
-. phiVcy = phi * Vcy = 1117.85 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2147.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5864.22 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2147.15 kN.
-. phiVsz = phi*Vsz = 1932.44 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2125.07 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5906.43 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2125.07 kN.
-. phiVsy = phi*Vsy = 1912.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 205.843 kN.
-. Vr = 3030.414 kN.
-. Ratio = Vu / Vr = 0.068 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 228.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 228.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0077 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0077 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0077 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112128,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5748.96       -77.72       -45.72      -230.61      -152.54
           ------------------------------------------------------------------------------
            DL+LL+Others     5748.96       -77.72       -45.72      -230.61      -152.54
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       45.72 kN-m.
           -. End Moments (My2) =       77.72 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -45.72 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -45.72 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      152.54 kN-m.
          -. End Moments (Mz2) =      230.61 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -152.54 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -152.54 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       194.266 kN-m.
          -. Mrz        =       647.494 kN-m.
          -. Mr         =       676.009 kN-m.
          -. Pu/Pr      =   0.236  --->  O.K !
          -. Muy/Mry    =   0.235  --->  O.K !
          -. Muz/Mrz    =   0.236  --->  O.K !
          -. Mu/Mr      =   0.236  --->  O.K !
          -. Ratio      =   0.236  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5732.31 kN.
          -. Vuz    =         64.10 kN.
          -. Muy    =        -77.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89

          -. Vuy    =        156.28 kN.
          -. Muz    =       -230.61 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.33 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.80
```

( ). Compute shear strength of concrete.
-. Vuz = 64.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1306.94 kN.
-. phiVcz = phi * Vcz = 1176.25 kN.

-. Vuy = 156.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1265.06 kN.
-. phiVcy = phi * Vcy = 1138.55 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2158.55 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5841.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2158.55 kN.
-. phiVsz = phi*Vsz = 1942.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2137.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5883.43 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2137.24 kN.
-. phiVsy = phi*Vsy = 1923.52 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 168.919 kN.
-. Vr = 3062.067 kN.
-. Ratio = Vu / Vr = 0.055 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 187.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 187.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0081 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0081 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0081 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112129,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5765.72       -45.72       -20.92      -152.54       -90.33
           ------------------------------------------------------------------------------
            DL+LL+Others     5765.72       -45.72       -20.92      -152.54       -90.33
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       20.92 kN-m.
           -. End Moments (My2) =       45.72 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -20.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -20.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       90.33 kN-m.
          -. End Moments (Mz2) =      152.54 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -90.33 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -90.33 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        88.941 kN-m.
          -. Mrz        =       382.267 kN-m.
          -. Mr         =       392.478 kN-m.
          -. Pu/Pr      =   0.236  --->  O.K !
          -. Muy/Mry    =   0.235  --->  O.K !
          -. Muz/Mrz    =   0.236  --->  O.K !
          -. Mu/Mr      =   0.236  --->  O.K !
          -. Ratio      =   0.236  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5749.06 kN.
          -. Vuz    =         49.89 kN.
          -. Muy    =        -45.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.96 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.94

          -. Vuy    =        124.67 kN.
          -. Muz    =       -152.54 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 49.89 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1326.58 kN.
-. phiVcz = phi * Vcz = 1193.93 kN.

-. Vuy = 124.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1285.01 kN.
-. phiVcy = phi * Vcy = 1156.51 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2168.18 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5821.90 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2168.18 kN.
-. phiVsz = phi*Vsz = 1951.37 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2147.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5863.48 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2147.53 kN.
-. phiVsy = phi*Vsy = 1932.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 134.283 kN.
-. Vr = 3089.283 kN.
-. Ratio = Vu / Vr = 0.043 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 149.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 149.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0085 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0085 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0085 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112130,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          5782.46       -20.92        -4.83       -90.33       -42.88
           ---------------------------------------------------------------------------
            DL+LL+Others    5782.46       -20.92        -4.83       -90.33       -42.88
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.83 kN-m.
           -. End Moments (My2) =       20.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       42.88 kN-m.
          -. End Moments (Mz2) =       90.33 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -42.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -42.88 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        20.427 kN-m.
          -. Mrz        =       180.987 kN-m.
          -. Mr         =       182.136 kN-m.
          -. Pu/Pr      =   0.237  --->  O.K !
          -. Muy/Mry    =   0.236  --->  O.K !
          -. Muz/Mrz    =   0.237  --->  O.K !
          -. Mu/Mr      =   0.237  --->  O.K !
          -. Ratio      =   0.237  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5782.46 kN.
          -. Vuz    =         36.98 kN.
          -. Muy    =         -4.83 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97

          -. Vuy    =         95.55 kN.
          -. Muz    =        -42.88 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 36.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1342.42 kN.
-. phiVcz = phi * Vcz = 1208.17 kN.

-. Vuy = 95.55 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1301.11 kN.
-. phiVcy = phi * Vcy = 1171.00 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2175.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5806.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2175.78 kN.
-. phiVsz = phi*Vsz = 1958.21 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2155.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5847.38 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2155.65 kN.
-. phiVsy = phi*Vsy = 1940.09 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 102.455 kN.
-. Vr = 3111.084 kN.
-. Ratio = Vu / Vr = 0.033 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 113.84 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 113.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0090 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0090 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0090 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112131,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5799.20        -4.83       -12.59       -42.88        -9.38
           ------------------------------------------------------------------------------
            DL+LL+Others     5799.20        -4.83       -12.59       -42.88        -9.38
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.83 kN-m.
           -. End Moments (My2) =       12.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -12.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -12.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        9.38 kN-m.
          -. End Moments (Mz2) =       42.88 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -9.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -9.38 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        52.955 kN-m.
          -. Mrz        =        39.494 kN-m.
          -. Mr         =        66.061 kN-m.
          -. Pu/Pr      =   0.238  --->  O.K !
          -. Muy/Mry    =   0.238  --->  O.K !
          -. Muz/Mrz    =   0.238  --->  O.K !
          -. Mu/Mr      =   0.238  --->  O.K !
          -. Ratio      =   0.238  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5799.20 kN.
          -. Vuz    =         25.50 kN.
          -. Muy    =        -12.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.99

          -. Vuy    =         69.25 kN.
          -. Muz    =         -9.38 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.90
```

( ). Compute shear strength of concrete.
-. Vuz = 25.50 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1350.55 kN.
-. phiVcz = phi * Vcz = 1215.49 kN.

-. Vuy = 69.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1309.39 kN.
-. phiVcy = phi * Vcy = 1178.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2179.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5797.94 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2179.63 kN.
-. phiVsz = phi*Vsz = 1961.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2159.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5839.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2159.77 kN.
-. phiVsy = phi*Vsy = 1943.79 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 73.798 kN.
-. Vr = 3122.240 kN.
-. Ratio = Vu / Vr = 0.024 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 82.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 82.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0091 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0091 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0091 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112132,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5815.93       -12.59       -18.98        -9.38       -24.06
           ------------------------------------------------------------------------------
            DL+LL+Others     5815.93       -12.59       -18.98        -9.38       -24.06
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       12.59 kN-m.
           -. End Moments (My2) =       18.98 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -18.98 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -18.98 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        9.38 kN-m.
          -. End Moments (Mz2) =       24.06 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -24.06 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -24.06 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        79.559 kN-m.
          -. Mrz        =       100.991 kN-m.
          -. Mr         =       128.564 kN-m.
          -. Pu/Pr      =   0.238  --->  O.K !
          -. Muy/Mry    =   0.239  --->  O.K !
          -. Muz/Mrz    =   0.238  --->  O.K !
          -. Mu/Mr      =   0.239  --->  O.K !
          -. Ratio      =   0.239  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5815.93 kN.
          -. Vuz    =         15.50 kN.
          -. Muy    =        -18.98 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =         46.02 kN.
          -. Muz    =        -24.06 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 15.50 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1357.63 kN.
-. phiVcz = phi * Vcz = 1221.86 kN.

-. Vuy = 46.02 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1316.60 kN.
-. phiVcy = phi * Vcy = 1184.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2182.95 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5790.86 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2182.95 kN.
-. phiVsz = phi*Vsz = 1964.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2163.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5831.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2163.32 kN.
-. phiVsy = phi*Vsy = 1946.99 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 48.556 kN.
-. Vr = 3131.924 kN.
-. Ratio = Vu / Vr = 0.016 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 53.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 53.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0092 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0092 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0092 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112133,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5832.66       -18.98       -21.70       -24.06       -34.34
           ------------------------------------------------------------------------------
            DL+LL+Others     5832.66       -18.98       -21.70       -24.06       -34.34
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       18.98 kN-m.
           -. End Moments (My2) =       21.70 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -21.70 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -21.70 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       24.06 kN-m.
          -. End Moments (Mz2) =       34.34 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -34.34 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -34.34 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        90.800 kN-m.
          -. Mrz        =       143.673 kN-m.
          -. Mr         =       169.960 kN-m.
          -. Pu/Pr      =   0.239  --->  O.K !
          -. Muy/Mry    =   0.239  --->  O.K !
          -. Muz/Mrz    =   0.239  --->  O.K !
          -. Mu/Mr      =   0.239  --->  O.K !
          -. Ratio      =   0.239  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5832.66 kN.
          -. Vuz    =          7.01 kN.
          -. Muy    =        -21.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =         25.98 kN.
          -. Muz    =        -34.34 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 7.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1360.14 kN.
-. phiVcz = phi * Vcz = 1224.12 kN.

-. Vuy = 25.98 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1319.16 kN.
-. phiVcy = phi * Vcy = 1187.24 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2184.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5788.35 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2184.12 kN.
-. phiVsz = phi*Vsz = 1965.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2164.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5829.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2164.57 kN.
-. phiVsy = phi*Vsy = 1948.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 26.912 kN.
-. Vr = 3135.352 kN.
-. Ratio = Vu / Vr = 0.009 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 29.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 29.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0092 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0092 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0092 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112134,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5849.37       -21.70       -22.76       -34.34       -40.85
           ------------------------------------------------------------------------------
            DL+LL+Others     5849.37       -21.70       -22.76       -34.34       -40.85
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       21.70 kN-m.
           -. End Moments (My2) =       22.76 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -22.76 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -22.76 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       34.34 kN-m.
          -. End Moments (Mz2) =       40.85 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -40.85 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -40.85 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        94.873 kN-m.
          -. Mrz        =       170.499 kN-m.
          -. Mr         =       195.118 kN-m.
          -. Pu/Pr      =   0.240  --->  O.K !
          -. Muy/Mry    =   0.240  --->  O.K !
          -. Muz/Mrz    =   0.240  --->  O.K !
          -. Mu/Mr      =   0.240  --->  O.K !
          -. Ratio      =   0.240  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5849.37 kN.
          -. Vuz    =          3.28 kN.
          -. Muy    =        -22.76 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =         16.93 kN.
          -. Muz    =        -40.85 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 3.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1359.15 kN.
-. phiVcz = phi * Vcz = 1223.24 kN.

-. Vuy = 16.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1318.15 kN.
-. phiVcy = phi * Vcy = 1186.34 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2183.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5789.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2183.67 kN.
-. phiVsz = phi*Vsz = 1965.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2164.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5830.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2164.08 kN.
-. phiVsy = phi*Vsy = 1947.67 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 17.240 kN.
-. Vr = 3134.010 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 19.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 19.16 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0092 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0092 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0092 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112135,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5866.08       -22.76       -22.77       -40.85       -44.17
           ------------------------------------------------------------------------------
            DL+LL+Others     5866.08       -22.76       -22.77       -40.85       -44.17
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       22.76 kN-m.
           -. End Moments (My2) =       22.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -22.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -22.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       40.85 kN-m.
          -. End Moments (Mz2) =       44.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -44.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -44.17 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        94.920 kN-m.
          -. Mrz        =       183.657 kN-m.
          -. Mr         =       206.736 kN-m.
          -. Pu/Pr      =   0.240  --->  O.K !
          -. Muy/Mry    =   0.240  --->  O.K !
          -. Muz/Mrz    =   0.240  --->  O.K !
          -. Mu/Mr      =   0.240  --->  O.K !
          -. Ratio      =   0.240  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5866.08 kN.
          -. Vuz    =          1.20 kN.
          -. Muy    =        -22.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =          9.81 kN.
          -. Muz    =        -44.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 1.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1358.41 kN.
-. phiVcz = phi * Vcz = 1222.57 kN.

-. Vuy = 9.81 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1317.40 kN.
-. phiVcy = phi * Vcy = 1185.66 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2183.32 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5790.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2183.32 kN.
-. phiVsz = phi*Vsz = 1964.99 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2163.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5831.09 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2163.71 kN.
-. phiVsy = phi*Vsy = 1947.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 9.884 kN.
-. Vr = 3132.996 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0093 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0093 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0093 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112136,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5882.78       -22.77       -20.00       -44.17       -40.50
           ------------------------------------------------------------------------------
            DL+LL+Others     5882.78       -22.77       -20.00       -44.17       -40.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       20.00 kN-m.
           -. End Moments (My2) =       22.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -20.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -20.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       40.50 kN-m.
          -. End Moments (Mz2) =       44.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -40.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -40.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        83.039 kN-m.
          -. Mrz        =       167.960 kN-m.
          -. Mr         =       187.366 kN-m.
          -. Pu/Pr      =   0.241  --->  O.K !
          -. Muy/Mry    =   0.241  --->  O.K !
          -. Muz/Mrz    =   0.241  --->  O.K !
          -. Mu/Mr      =   0.241  --->  O.K !
          -. Ratio      =   0.241  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5882.78 kN.
          -. Vuz    =          5.78 kN.
          -. Muy    =        -20.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =          7.67 kN.
          -. Muz    =        -40.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 5.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1357.93 kN.
-. phiVcz = phi * Vcz = 1222.14 kN.

-. Vuy = 7.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1316.91 kN.
-. phiVcy = phi * Vcy = 1185.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2183.10 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5790.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2183.10 kN.
-. phiVsz = phi*Vsz = 1964.79 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2163.47 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5831.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2163.47 kN.
-. phiVsy = phi*Vsy = 1947.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 9.610 kN.
-. Vr = 3132.341 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0093 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0093 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0093 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112137,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5899.48       -20.00       -15.49       -40.50       -32.25
           ------------------------------------------------------------------------------
            DL+LL+Others     5899.48       -20.00       -15.49       -40.50       -32.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       15.49 kN-m.
           -. End Moments (My2) =       20.00 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -15.49 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -15.49 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       32.25 kN-m.
          -. End Moments (Mz2) =       40.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -32.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -32.25 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        64.094 kN-m.
          -. Mrz        =       133.404 kN-m.
          -. Mr         =       148.002 kN-m.
          -. Pu/Pr      =   0.242  --->  O.K !
          -. Muy/Mry    =   0.242  --->  O.K !
          -. Muz/Mrz    =   0.242  --->  O.K !
          -. Mu/Mr      =   0.242  --->  O.K !
          -. Ratio      =   0.242  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5882.82 kN.
          -. Vuz    =          9.02 kN.
          -. Muy    =        -20.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =         16.53 kN.
          -. Muz    =        -40.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 9.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1356.37 kN.
-. phiVcz = phi * Vcz = 1220.74 kN.

-. Vuy = 16.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1315.32 kN.
-. phiVcy = phi * Vcy = 1183.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2182.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5792.11 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2182.37 kN.
-. phiVsz = phi*Vsz = 1964.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2162.69 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5833.17 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2162.69 kN.
-. phiVsy = phi*Vsy = 1946.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 18.830 kN.
-. Vr = 3130.209 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 20.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 20.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0093 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0093 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0093 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112138,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5916.16       -15.49       -10.27       -32.25       -21.80
           ------------------------------------------------------------------------------
            DL+LL+Others     5916.16       -15.49       -10.27       -32.25       -21.80
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       10.27 kN-m.
           -. End Moments (My2) =       15.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -10.27 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -10.27 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       21.80 kN-m.
          -. End Moments (Mz2) =       32.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -21.80 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -21.80 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        42.345 kN-m.
          -. Mrz        =        89.910 kN-m.
          -. Mr         =        99.383 kN-m.
          -. Pu/Pr      =   0.242  --->  O.K !
          -. Muy/Mry    =   0.242  --->  O.K !
          -. Muz/Mrz    =   0.242  --->  O.K !
          -. Mu/Mr      =   0.242  --->  O.K !
          -. Ratio      =   0.242  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5899.51 kN.
          -. Vuz    =         10.45 kN.
          -. Muy    =        -15.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =         20.92 kN.
          -. Muz    =        -32.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 10.45 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1356.03 kN.
-. phiVcz = phi * Vcz = 1220.43 kN.

-. Vuy = 20.92 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1314.97 kN.
-. phiVcy = phi * Vcy = 1183.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2182.21 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5792.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2182.21 kN.
-. phiVsz = phi*Vsz = 1963.99 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2162.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5833.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2162.52 kN.
-. phiVsy = phi*Vsy = 1946.27 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 23.383 kN.
-. Vr = 3129.741 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 25.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 25.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0093 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0093 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0093 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112139,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5932.84       -10.27        -5.30       -21.80       -11.43
           ------------------------------------------------------------------------------
            DL+LL+Others     5932.84       -10.27        -5.30       -21.80       -11.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        5.30 kN-m.
           -. End Moments (My2) =       10.27 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -5.30 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -5.30 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       11.43 kN-m.
          -. End Moments (Mz2) =       21.80 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -11.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -11.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        21.812 kN-m.
          -. Mrz        =        47.030 kN-m.
          -. Mr         =        51.842 kN-m.
          -. Pu/Pr      =   0.243  --->  O.K !
          -. Muy/Mry    =   0.243  --->  O.K !
          -. Muz/Mrz    =   0.243  --->  O.K !
          -. Mu/Mr      =   0.243  --->  O.K !
          -. Ratio      =   0.243  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5932.84 kN.
          -. Vuz    =          9.92 kN.
          -. Muy    =         -5.30 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =         20.73 kN.
          -. Muz    =        -11.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 9.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1356.39 kN.
-. phiVcz = phi * Vcz = 1220.76 kN.

-. Vuy = 20.73 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1315.34 kN.
-. phiVcy = phi * Vcy = 1183.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2182.38 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5792.09 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2182.38 kN.
-. phiVsz = phi*Vsz = 1964.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2162.70 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5833.14 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2162.70 kN.
-. phiVsy = phi*Vsy = 1946.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 22.981 kN.
-. Vr = 3130.239 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 25.53 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 25.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0095 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0095 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0095 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112140,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5949.51        -5.30        -1.57       -11.43        -3.42
           ------------------------------------------------------------------------------
            DL+LL+Others     5949.51        -5.30        -1.57       -11.43        -3.42
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.57 kN-m.
           -. End Moments (My2) =        5.30 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.42 kN-m.
          -. End Moments (Mz2) =       11.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.42 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.42 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         6.416 kN-m.
          -. Mrz        =        14.029 kN-m.
          -. Mr         =        15.427 kN-m.
          -. Pu/Pr      =   0.244  --->  O.K !
          -. Muy/Mry    =   0.244  --->  O.K !
          -. Muz/Mrz    =   0.244  --->  O.K !
          -. Mu/Mr      =   0.244  --->  O.K !
          -. Ratio      =   0.244  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5949.51 kN.
          -. Vuz    =          7.48 kN.
          -. Muy    =         -1.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =         16.03 kN.
          -. Muz    =         -3.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 7.48 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1356.78 kN.
-. phiVcz = phi * Vcz = 1221.10 kN.

-. Vuy = 16.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1315.73 kN.
-. phiVcy = phi * Vcy = 1184.16 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2182.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5791.71 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2182.56 kN.
-. phiVsz = phi*Vsz = 1964.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2162.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5832.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2162.89 kN.
-. phiVsy = phi*Vsy = 1946.60 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 17.685 kN.
-. Vr = 3130.760 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 19.65 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 19.65 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0095 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0095 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0095 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112141,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5966.17        -1.57         0.00        -3.42         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5966.17        -1.57         0.00        -3.42         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        1.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        3.42 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.244  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.244  --->  O.K !
          -. Ratio      =   0.244  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5966.17 kN.
          -. Vuz    =          3.13 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.92

          -. Vuy    =          6.84 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 3.13 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1317.80 kN.
-. phiVcz = phi * Vcz = 1186.02 kN.

-. Vuy = 6.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1317.80 kN.
-. phiVcy = phi * Vcy = 1186.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2163.90 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5830.69 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2163.90 kN.
-. phiVsz = phi*Vsz = 1947.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2163.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5830.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2163.90 kN.
-. phiVsy = phi*Vsy = 1947.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 7.522 kN.
-. Vr = 3133.529 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 8.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 8.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0096 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0096 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0096 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112202,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -2464.70       945.19       947.51      1300.68       574.39
           ---------------------------------------------------------------------------
            DL+LL+Others    -2464.70       945.19       947.51      1300.68       574.39
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5244.051 kN.
          -. Mry        =      2004.804 kN-m.
          -. Mrz        =      2785.984 kN-m.
          -. Mr         =      3432.338 kN-m.
          -. Pu/Pr      =   0.470  --->  O.K !
          -. Muy/Mry    =   0.471  --->  O.K !
          -. Muz/Mrz    =   0.467  --->  O.K !
          -. Mu/Mr      =   0.471  --->  O.K !
          -. Ratio      =   0.471  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5476.28 kN.
          -. Vuz    =        402.58 kN.
          -. Muy    =       -808.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.92 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.12
```

-. Vuy = 1522.40 kN.
-. Muz = -1589.87 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 35.41 Deg. [Clause 5.8.3.4.2]
-. betay = 2.02

( ). Compute shear strength of concrete.
-. Vuz = 402.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 956.33 kN.
-. phiVcz = phi * Vcz = 860.70 kN.

-. Vuy = 1522.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 913.77 kN.
-. phiVcy = phi * Vcy = 822.39 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1938.13 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6192.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1938.13 kN.
-. phiVsz = phi*Vsz = 1744.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1903.03 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6234.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1903.03 kN.
-. phiVsy = phi*Vsy = 1712.73 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1574.731 kN.
-. Vr = 2535.117 kN.
-. Ratio = Vu / Vr = 0.621 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1749.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1749.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112203,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2453.00       947.51       962.70       574.39         5.93
           ---------------------------------------------------------------------------
           DL+LL+Others    -2453.00       947.51       962.70       574.39         5.93
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6568.068 kN.
          -. Mry        =      2531.887 kN-m.
          -. Mrz        =      1546.762 kN-m.
          -. Mr         =      2966.972 kN-m.
          -. Pu/Pr      =   0.373  --->  O.K !
          -. Muy/Mry    =   0.374  --->  O.K !
          -. Muz/Mrz    =   0.371  --->  O.K !
          -. Mu/Mr      =   0.374  --->  O.K !
          -. Ratio      =   0.374  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5509.89 kN.
          -. Vuz    =        363.42 kN.
          -. Muy    =       -876.36 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.16 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =       1357.30 kN.
          -. Muz    =       -230.78 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.18

     ( ). Compute shear strength of concrete.
          -. Vuz       =      363.42 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1029.62 kN.
          -. phiVcz    = phi * Vcz =      926.65 kN.

          -. Vuy       =     1357.30 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      986.44 kN.
          -. phiVcy    = phi * Vcy =      887.80 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1993.45 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6118.87 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1993.45 kN.
          -. phiVsz   = phi*Vsz =     1794.11 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1961.59 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6162.04 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1961.59 kN.
          -. phiVsy   = phi*Vsy =     1765.44 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1405.111 kN.
          -. Vr       =    2653.233 kN.
          -. Ratio    = Vu / Vr = 0.530  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1561.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1561.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112204,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -2429.31       962.70       969.94         5.93       550.69
           ------------------------------------------------------------------------------
            DL+LL+Others    -2429.31       962.70       969.94         5.93       550.69
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6506.918 kN.
          -. Mry        =      2596.160 kN-m.
          -. Mrz        =      1477.456 kN-m.
          -. Mr         =      2987.126 kN-m.
          -. Pu/Pr      =   0.373  --->  O.K !
          -. Muy/Mry    =   0.374  --->  O.K !
          -. Muz/Mrz    =   0.373  --->  O.K !
          -. Mu/Mr      =   0.374  --->  O.K !
          -. Ratio      =   0.374  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5526.83 kN.
          -. Vuz    =        324.58 kN.
          -. Muy    =       -906.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.32
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```
          -. Vuy    =       1191.50 kN.
          -. Muz    =       -744.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.23

     ( ). Compute shear strength of concrete.
          -. Vuz       =      324.58 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1050.36 kN.
          -. phiVcz    = phi * Vcz =      945.33 kN.

          -. Vuy       =     1191.50 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1007.09 kN.
          -. phiVcy    = phi * Vcy =      906.38 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2008.06 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6098.12 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2008.06 kN.
          -. phiVsz   = phi*Vsz =     1807.26 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1977.08 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6141.40 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1977.08 kN.
          -. phiVsy   = phi*Vsy =     1779.38 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1234.916 kN.
          -. Vr       =    2685.755 kN.
          -. Ratio    = Vu / Vr = 0.460  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1372.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1372.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112205,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2417.60       969.94       967.97       550.69      1045.01
           ---------------------------------------------------------------------------
           DL+LL+Others    -2417.60       969.94       967.97       550.69      1045.01
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5637.722 kN.
          -. Mry        =      2248.271 kN-m.
          -. Mrz        =      2414.723 kN-m.
          -. Mr         =      3299.335 kN-m.
          -. Pu/Pr      =   0.429  --->  O.K !
          -. Muy/Mry    =   0.431  --->  O.K !
          -. Muz/Mrz    =   0.433  --->  O.K !
          -. Mu/Mr      =   0.433  --->  O.K !
          -. Ratio      =   0.433  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5543.77 kN.
          -. Vuz    =        286.43 kN.
          -. Muy    =       -924.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.27
```

-. Vuy = 1026.79 kN.
-. Muz = -1209.91 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.63 Deg. [Clause 5.8.3.4.2]
-. betay = 2.18

( ). Compute shear strength of concrete.
-. Vuz = 286.43 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1026.22 kN.
-. phiVcz = phi * Vcz = 923.60 kN.

-. Vuy = 1026.79 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 983.07 kN.
-. phiVcy = phi * Vcy = 884.76 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1991.02 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6122.26 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1991.02 kN.
-. phiVsz = phi*Vsz = 1791.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1959.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6165.42 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1959.02 kN.
-. phiVsy = phi*Vsy = 1763.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1065.993 kN.
-. Vr = 2647.880 kN.
-. Ratio = Vu / Vr = 0.403 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1184.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1184.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112206,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2405.88       967.97       956.92      1045.01      1463.46
           ---------------------------------------------------------------------------
           DL+LL+Others    -2405.88       967.97       956.92      1045.01      1463.46
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4900.648 kN.
          -. Mry        =      1941.105 kN-m.
          -. Mrz        =      2978.150 kN-m.
          -. Mr         =      3554.893 kN-m.
          -. Pu/Pr      =   0.491  --->  O.K !
          -. Muy/Mry    =   0.493  --->  O.K !
          -. Muz/Mrz    =   0.491  --->  O.K !
          -. Mu/Mr      =   0.493  --->  O.K !
          -. Ratio      =   0.493  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5560.70 kN.
          -. Vuz    =        249.33 kN.
          -. Muy    =       -931.66 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.22
```

```
          -. Vuy    =       865.01 kN.
          -. Muz    =     -1600.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.13

     ( ). Compute shear strength of concrete.
          -. Vuz       =     249.33 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1005.06 kN.
          -. phiVcz    = phi * Vcz =      904.55 kN.

          -. Vuy       =     865.01 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      962.05 kN.
          -. phiVcy    = phi * Vcy =      865.84 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1975.58 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6143.43 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1975.58 kN.
          -. phiVsz   = phi*Vsz =     1778.02 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1942.66 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6186.44 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1942.66 kN.
          -. phiVsy   = phi*Vsy =     1748.40 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     900.229 kN.
          -. Vr       =    2614.236 kN.
          -. Ratio    = Vu / Vr = 0.344  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1000.25 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1000.25 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112207,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2394.15       956.92       940.78      1463.46      1807.21
           ---------------------------------------------------------------------------
           DL+LL+Others    -2394.15       956.92       940.78      1463.46      1807.21
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4381.699 kN.
          -. Mry        =      1712.655 kN-m.
          -. Mrz        =      3295.318 kN-m.
          -. Mr         =      3713.800 kN-m.
          -. Pu/Pr      =   0.546  --->  O.K !
          -. Muy/Mry    =   0.549  --->  O.K !
          -. Muz/Mrz    =   0.548  --->  O.K !
          -. Mu/Mr      =   0.549  --->  O.K !
          -. Ratio      =   0.549  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5577.62 kN.
          -. Vuz    =        213.70 kN.
          -. Muy    =       -931.74 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.19
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```
          -. Vuy    =       707.99 kN.
          -. Muz    =     -1918.20 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.09

     ( ). Compute shear strength of concrete.
          -. Vuz       =      213.70 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      989.34 kN.
          -. phiVcz    = phi * Vcz =      890.41 kN.

          -. Vuy       =      707.99 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      946.45 kN.
          -. phiVcy    = phi * Vcy =      851.81 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1963.80 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6159.15 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1963.80 kN.
          -. phiVsz   = phi*Vsz =     1767.42 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1930.18 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6202.04 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1930.18 kN.
          -. phiVsy   = phi*Vsy =     1737.17 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     739.536 kN.
          -. Vr       =    2588.972 kN.
          -. Ratio    = Vu / Vr = 0.286  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 821.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 821.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112208,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2382.42       940.78       924.41      1807.21      2076.36
           ---------------------------------------------------------------------------
           DL+LL+Others    -2382.42       940.78       924.41      1807.21      2076.36
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4013.592 kN.
          -. Mry        =      1562.649 kN-m.
          -. Mrz        =      3500.100 kN-m.
          -. Mr         =      3833.089 kN-m.
          -. Pu/Pr      =   0.594  --->  O.K !
          -. Muy/Mry    =   0.592  --->  O.K !
          -. Muz/Mrz    =   0.593  --->  O.K !
          -. Mu/Mr      =   0.594  --->  O.K !
          -. Ratio      =   0.594  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5594.54 kN.
          -. Vuz    =        179.94 kN.
          -. Muy    =       -929.50 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.67 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.17
```

-. Vuy = 557.53 kN.
-. Muz = -2163.06 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 35.14 Deg. [Clause 5.8.3.4.2]
-. betay = 2.07

( ). Compute shear strength of concrete.
-. Vuz = 179.94 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 979.44 kN.
-. phiVcz = phi * Vcz = 881.49 kN.

-. Vuy = 557.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 936.64 kN.
-. phiVcy = phi * Vcy = 842.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1956.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6169.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1956.23 kN.
-. phiVsz = phi*Vsz = 1760.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1922.18 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6211.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1922.18 kN.
-. phiVsy = phi*Vsy = 1729.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 585.843 kN.
-. Vr = 2572.935 kN.
-. Ratio = Vu / Vr = 0.228 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 650.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 650.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112209,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2370.68       924.41       901.68      2076.36      2275.00
           ---------------------------------------------------------------------------
           DL+LL+Others    -2370.68       924.41       901.68      2076.36      2275.00
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3759.496 kN.
          -. Mry        =      1454.051 kN-m.
          -. Mrz        =      3630.686 kN-m.
          -. Mr         =      3911.028 kN-m.
          -. Pu/Pr      =   0.631  --->  O.K !
          -. Muy/Mry    =   0.620  --->  O.K !
          -. Muz/Mrz    =   0.627  --->  O.K !
          -. Mu/Mr      =   0.631  --->  O.K !
          -. Ratio      =   0.631  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5611.44 kN.
          -. Vuz    =        148.42 kN.
          -. Muy    =       -918.88 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.16
```

```
          -. Vuy    =       415.37 kN.
          -. Muz    =     -2339.34 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.06

     ( ). Compute shear strength of concrete.
          -. Vuz       =     148.42 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     975.26 kN.
          -. phiVcz    = phi * Vcz =     877.73 kN.

          -. Vuy       =     415.37 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     932.50 kN.
          -. phiVcy    = phi * Vcy =     839.25 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1953.00 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6173.23 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1953.00 kN.
          -. phiVsz   = phi*Vsz =     1757.70 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1918.76 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6215.99 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1918.76 kN.
          -. phiVsy   = phi*Vsy =     1726.89 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     441.089 kN.
          -. Vr       =    2566.133 kN.
          -. Ratio    = Vu / Vr = 0.172  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 490.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 490.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112210,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2358.93       901.68       871.75      2275.00      2408.09
           ---------------------------------------------------------------------------
           DL+LL+Others    -2358.93       901.68       871.75      2275.00      2408.09
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3660.604 kN.
          -. Mry        =      1346.283 kN-m.
          -. Mrz        =      3700.443 kN-m.
          -. Mr         =      3937.735 kN-m.
          -. Pu/Pr      =   0.644  --->  O.K !
          -. Muy/Mry    =   0.648  --->  O.K !
          -. Muz/Mrz    =   0.651  --->  O.K !
          -. Mu/Mr      =   0.651  --->  O.K !
          -. Ratio      =   0.651  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5628.34 kN.
          -. Vuz    =        119.70 kN.
          -. Muy    =       -899.09 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.70 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.16
```

```
          -. Vuy    =       283.25 kN.
          -. Muz    =     -2452.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.07

     ( ). Compute shear strength of concrete.
          -. Vuz       =     119.70 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     976.24 kN.
          -. phiVcz    = phi * Vcz =     878.62 kN.

          -. Vuy       =     283.25 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     933.47 kN.
          -. phiVcy    = phi * Vcy =     840.12 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1953.76 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6172.24 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1953.76 kN.
          -. phiVsz   = phi*Vsz =     1758.39 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1919.57 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6215.01 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1919.57 kN.
          -. phiVsy   = phi*Vsy =     1727.61 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     307.504 kN.
          -. Vr       =    2567.735 kN.
          -. Ratio    = Vu / Vr = 0.120  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 341.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 341.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112211,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2347.17       871.75       835.26      2408.09      2481.35
           ---------------------------------------------------------------------------
           DL+LL+Others    -2347.17       871.75       835.26      2408.09      2481.35
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3571.020 kN.
          -. Mry        =      1266.104 kN-m.
          -. Mrz        =      3756.147 kN-m.
          -. Mr         =      3963.794 kN-m.
          -. Pu/Pr      =   0.657  --->  O.K !
          -. Muy/Mry    =   0.660  --->  O.K !
          -. Muz/Mrz    =   0.661  --->  O.K !
          -. Mu/Mr      =   0.661  --->  O.K !
          -. Ratio      =   0.661  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5645.23 kN.
          -. Vuz    =        109.13 kN.
          -. Muy    =       -870.86 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.17
```

```
          -. Vuy    =       162.53 kN.
          -. Muz    =     -2507.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.12 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.08

     ( ). Compute shear strength of concrete.
          -. Vuz       =     109.13 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     981.02 kN.
          -. phiVcz    = phi * Vcz =     882.91 kN.

          -. Vuy       =     162.53 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     938.20 kN.
          -. phiVcy    = phi * Vcy =     844.38 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1957.44 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6167.47 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1957.44 kN.
          -. phiVsz   = phi*Vsz =     1761.70 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1923.46 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6210.29 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1923.46 kN.
          -. phiVsy   = phi*Vsy =     1731.11 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     195.771 kN.
          -. Vr       =    2575.496 kN.
          -. Ratio    = Vu / Vr = 0.076  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 217.52 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 217.52 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112212,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2335.41       835.26       793.19      2481.35      2501.49
           ---------------------------------------------------------------------------
           DL+LL+Others    -2335.41       835.26       793.19      2481.35      2501.49
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3528.467 kN.
          -. Mry        =      1200.975 kN-m.
          -. Mrz        =      3790.925 kN-m.
          -. Mr         =      3976.614 kN-m.
          -. Pu/Pr      =   0.662  --->  O.K !
          -. Muy/Mry    =   0.660  --->  O.K !
          -. Muz/Mrz    =   0.660  --->  O.K !
          -. Mu/Mr      =   0.662  --->  O.K !
          -. Ratio      =   0.662  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5645.46 kN.
          -. Vuz    =        118.79 kN.
          -. Muy    =       -870.86 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
```

```
          -. Vuy    =         55.35 kN.
          -. Muz    =      -2507.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.05 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.09

     ( ). Compute shear strength of concrete.
          -. Vuz       =      118.79 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      986.75 kN.
          -. phiVcz    = phi * Vcz =      888.07 kN.

          -. Vuy       =       55.35 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      943.88 kN.
          -. phiVcy    = phi * Vcy =      849.49 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1961.83 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6161.74 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1961.83 kN.
          -. phiVsz   = phi*Vsz =     1765.64 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1928.10 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6204.60 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1928.10 kN.
          -. phiVsy   = phi*Vsy =     1735.29 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     131.053 kN.
          -. Vr       =    2584.784 kN.
          -. Ratio    = Vu / Vr = 0.051  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 145.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 145.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112213,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2335.63       793.19       747.03      2501.49      2475.07
           ---------------------------------------------------------------------------
           DL+LL+Others    -2335.63       793.19       747.03      2501.49      2475.07
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3528.467 kN.
          -. Mry        =      1200.975 kN-m.
          -. Mrz        =      3790.925 kN-m.
          -. Mr         =      3976.614 kN-m.
          -. Pu/Pr      =   0.662  --->  O.K !
          -. Muy/Mry    =   0.660  --->  O.K !
          -. Muz/Mrz    =   0.660  --->  O.K !
          -. Mu/Mr      =   0.662  --->  O.K !
          -. Ratio      =   0.662  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3948.30 kN.
          -. Vuz    =        159.38 kN.
          -. Muy    =      -1824.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.49
```

```
          -. Vuy    =         50.27 kN.
          -. Muz    =      -1188.88 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.68 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.40

     ( ). Compute shear strength of concrete.
          -. Vuz       =      159.38 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1125.56 kN.
          -. phiVcz    = phi * Vcz =     1013.01 kN.

          -. Vuy       =       50.27 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1082.19 kN.
          -. phiVcy    = phi * Vcy =      973.97 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2057.58 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6022.92 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2057.58 kN.
          -. phiVsz   = phi*Vsz =     1851.82 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2029.65 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6066.30 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2029.65 kN.
          -. phiVsy   = phi*Vsy =     1826.69 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     167.119 kN.
          -. Vr       =    2800.659 kN.
          -. Ratio    = Vu / Vr = 0.060  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 185.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 185.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112214,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2323.85       747.03       695.37      2475.07      2396.70
           ---------------------------------------------------------------------------
           DL+LL+Others    -2323.85       747.03       695.37      2475.07      2396.70
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3572.527 kN.
          -. Mry        =      1142.122 kN-m.
          -. Mrz        =      3795.582 kN-m.
          -. Mr         =      3963.696 kN-m.
          -. Pu/Pr      =   0.650  --->  O.K !
          -. Muy/Mry    =   0.654  --->  O.K !
          -. Muz/Mrz    =   0.652  --->  O.K !
          -. Mu/Mr      =   0.654  --->  O.K !
          -. Ratio      =   0.654  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5679.20 kN.
          -. Vuz    =        134.95 kN.
          -. Muy    =       -794.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
```

```
          -. Vuy    =       185.12 kN.
          -. Muz    =     -2470.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.08

     ( ). Compute shear strength of concrete.
          -. Vuz       =     134.95 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      982.64 kN.
          -. phiVcz    = phi * Vcz =      884.37 kN.

          -. Vuy       =     185.12 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      939.81 kN.
          -. phiVcy    = phi * Vcy =      845.83 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1958.69 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6165.85 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1958.69 kN.
          -. phiVsz   = phi*Vsz =     1762.82 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1924.78 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6208.68 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1924.78 kN.
          -. phiVsy   = phi*Vsy =     1732.30 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     229.089 kN.
          -. Vr       =    2578.129 kN.
          -. Ratio    = Vu / Vr = 0.089  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 254.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 254.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112215,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2312.06       695.37       637.69      2396.70      2264.64
           ---------------------------------------------------------------------------
           DL+LL+Others    -2312.06       695.37       637.69      2396.70      2264.64
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3660.132 kN.
          -. Mry        =      1091.493 kN-m.
          -. Mrz        =      3783.485 kN-m.
          -. Mr         =      3937.781 kN-m.
          -. Pu/Pr      =   0.632  --->  O.K !
          -. Muy/Mry    =   0.637  --->  O.K !
          -. Muz/Mrz    =   0.633  --->  O.K !
          -. Mu/Mr      =   0.637  --->  O.K !
          -. Ratio      =   0.637  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5696.07 kN.
          -. Vuz    =        141.70 kN.
          -. Muy    =       -745.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.61 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
```

```
          -. Vuy    =       285.12 kN.
          -. Muz    =     -2380.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.08

     ( ). Compute shear strength of concrete.
          -. Vuz       =     141.70 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      984.30 kN.
          -. phiVcz    = phi * Vcz =      885.87 kN.

          -. Vuy       =     285.12 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      941.45 kN.
          -. phiVcy    = phi * Vcy =      847.31 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1959.96 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6164.19 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1959.96 kN.
          -. phiVsz   = phi*Vsz =     1763.96 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1926.12 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6207.03 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1926.12 kN.
          -. phiVsy   = phi*Vsy =     1733.51 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     318.393 kN.
          -. Vr       =    2580.816 kN.
          -. Ratio    = Vu / Vr = 0.123  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 353.77 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 353.77 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112216,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2300.26       637.69       576.00      2264.64      2092.44
           ---------------------------------------------------------------------------
           DL+LL+Others    -2300.26       637.69       576.00      2264.64      2092.44
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3834.584 kN.
          -. Mry        =      1043.584 kN-m.
          -. Mrz        =      3742.740 kN-m.
          -. Mr         =      3885.508 kN-m.
          -. Pu/Pr      =   0.600  --->  O.K !
          -. Muy/Mry    =   0.611  --->  O.K !
          -. Muz/Mrz    =   0.605  --->  O.K !
          -. Mu/Mr      =   0.611  --->  O.K !
          -. Ratio      =   0.611  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5712.92 kN.
          -. Vuz    =        147.55 kN.
          -. Muy    =       -688.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
```

```
          -. Vuy    =       358.96 kN.
          -. Muz    =     -2239.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.99 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.10

     ( ). Compute shear strength of concrete.
          -. Vuz       =     147.55 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      992.99 kN.
          -. phiVcz    = phi * Vcz =      893.69 kN.

          -. Vuy       =     358.96 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      950.07 kN.
          -. phiVcy    = phi * Vcy =      855.06 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1966.56 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6155.50 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1966.56 kN.
          -. phiVsz   = phi*Vsz =     1769.90 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1933.10 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6198.42 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1933.10 kN.
          -. phiVsy   = phi*Vsy =     1739.79 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     388.101 kN.
          -. Vr       =    2594.855 kN.
          -. Ratio    = Vu / Vr = 0.150  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 431.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 431.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112217,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2288.46       576.00       512.36      2092.44      1893.75
           ---------------------------------------------------------------------------
           DL+LL+Others    -2288.46       576.00       512.36      2092.44      1893.75
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4011.229 kN.
          -. Mry        =      1003.360 kN-m.
          -. Mrz        =      3698.755 kN-m.
          -. Mr         =      3832.430 kN-m.
          -. Pu/Pr      =   0.571  --->  O.K !
          -. Muy/Mry    =   0.574  --->  O.K !
          -. Muz/Mrz    =   0.566  --->  O.K !
          -. Mu/Mr      =   0.574  --->  O.K !
          -. Ratio      =   0.574  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5729.76 kN.
          -. Vuz    =        150.00 kN.
          -. Muy    =       -625.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

-. Vuy = 407.98 kN.
-. Muz = -2060.99 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.82 Deg. [Clause 5.8.3.4.2]
-. betay = 2.14

( ). Compute shear strength of concrete.
-. Vuz = 150.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1007.99 kN.
-. phiVcz = phi * Vcz = 907.19 kN.

-. Vuy = 407.98 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 964.95 kN.
-. phiVcy = phi * Vcy = 868.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1977.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6140.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1977.75 kN.
-. phiVsz = phi*Vsz = 1779.97 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1944.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6183.54 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1944.95 kN.
-. phiVsy = phi*Vsy = 1750.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 434.681 kN.
-. Vr = 2618.912 kN.
-. Ratio = Vu / Vr = 0.166 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 482.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 482.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112218,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2276.65       512.36       448.66      1893.75      1679.37
           ---------------------------------------------------------------------------
           DL+LL+Others    -2276.65       512.36       448.66      1893.75      1679.37
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4319.511 kN.
          -. Mry        =       969.680 kN-m.
          -. Mrz        =      3609.644 kN-m.
          -. Mr         =      3737.621 kN-m.
          -. Pu/Pr      =   0.527  --->  O.K !
          -. Muy/Mry    =   0.528  --->  O.K !
          -. Muz/Mrz    =   0.525  --->  O.K !
          -. Mu/Mr      =   0.528  --->  O.K !
          -. Ratio      =   0.528  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5746.60 kN.
          -. Vuz    =        148.72 kN.
          -. Muy    =       -560.04 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.18 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =       434.50 kN.
          -. Muz    =     -1858.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.18

     ( ). Compute shear strength of concrete.
          -. Vuz       =     148.72 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1028.25 kN.
          -. phiVcz    = phi * Vcz =      925.43 kN.

          -. Vuy       =     434.50 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      985.09 kN.
          -. phiVcy    = phi * Vcy =      886.58 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1992.48 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6120.23 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1992.48 kN.
          -. phiVsz   = phi*Vsz =     1793.23 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1960.56 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6163.40 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1960.56 kN.
          -. phiVsy   = phi*Vsy =     1764.51 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     459.247 kN.
          -. Vr       =    2651.085 kN.
          -. Ratio    = Vu / Vr = 0.173  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 510.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 510.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112219,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2264.84       448.66       386.64      1679.37      1459.51
           ---------------------------------------------------------------------------
           DL+LL+Others    -2264.84       448.66       386.64      1679.37      1459.51
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4731.858 kN.
          -. Mry        =       934.091 kN-m.
          -. Mrz        =      3479.111 kN-m.
          -. Mr         =      3602.324 kN-m.
          -. Pu/Pr      =   0.479  --->  O.K !
          -. Muy/Mry    =   0.480  --->  O.K !
          -. Muz/Mrz    =   0.483  --->  O.K !
          -. Mu/Mr      =   0.483  --->  O.K !
          -. Ratio      =   0.483  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5763.43 kN.
          -. Vuz    =        143.95 kN.
          -. Muy    =       -493.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.33
```

-. Vuy = 441.22 kN.
-. Muz = -1642.43 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.36 Deg. [Clause 5.8.3.4.2]
-. betay = 2.23

( ). Compute shear strength of concrete.
-. Vuz = 143.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1052.93 kN.
-. phiVcz = phi * Vcz = 947.63 kN.

-. Vuy = 441.22 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1009.64 kN.
-. phiVcy = phi * Vcy = 908.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2009.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6095.56 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2009.84 kN.
-. phiVsz = phi*Vsz = 1808.86 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1978.97 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6138.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1978.97 kN.
-. phiVsy = phi*Vsy = 1781.07 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 464.107 kN.
-. Vr = 2689.746 kN.
-. Ratio = Vu / Vr = 0.173 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 515.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 515.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112220,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2253.01       386.64       327.86      1459.51      1243.29
           ---------------------------------------------------------------------------
           DL+LL+Others    -2253.01       386.64       327.86      1459.51      1243.29
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5160.979 kN.
          -. Mry        =       901.350 kN-m.
          -. Mrz        =      3341.444 kN-m.
          -. Mr         =      3460.878 kN-m.
          -. Pu/Pr      =   0.437  --->  O.K !
          -. Muy/Mry    =   0.429  --->  O.K !
          -. Muz/Mrz    =   0.437  --->  O.K !
          -. Mu/Mr      =   0.437  --->  O.K !
          -. Ratio      =   0.437  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5780.26 kN.
          -. Vuz    =        136.09 kN.
          -. Muy    =       -427.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.39
```

-. Vuy = 431.16 kN.
-. Muz = -1422.44 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.09 Deg. [Clause 5.8.3.4.2]
-. betay = 2.30

( ). Compute shear strength of concrete.
-. Vuz = 136.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1081.03 kN.
-. phiVcz = phi * Vcz = 972.93 kN.

-. Vuy = 431.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1037.67 kN.
-. phiVcy = phi * Vcy = 933.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2028.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6067.45 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2028.89 kN.
-. phiVsz = phi*Vsz = 1826.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1999.18 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6110.82 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1999.18 kN.
-. phiVsy = phi*Vsy = 1799.26 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 452.126 kN.
-. Vr = 2733.158 kN.
-. Ratio = Vu / Vr = 0.165 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 502.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 502.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112221,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2241.18       327.86       273.58      1243.29      1038.15
           ---------------------------------------------------------------------------
           DL+LL+Others    -2241.18       327.86       273.58      1243.29      1038.15
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5711.953 kN.
          -. Mry        =       839.308 kN-m.
          -. Mrz        =      3162.402 kN-m.
          -. Mr         =      3271.884 kN-m.
          -. Pu/Pr      =   0.392  --->  O.K !
          -. Muy/Mry    =   0.391  --->  O.K !
          -. Muz/Mrz    =   0.393  --->  O.K !
          -. Mu/Mr      =   0.393  --->  O.K !
          -. Ratio      =   0.393  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5797.07 kN.
          -. Vuz    =        125.59 kN.
          -. Muy    =       -363.89 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.44 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.46
```

```
          -. Vuy    =       407.06 kN.
          -. Muz    =     -1207.38 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.36

     ( ). Compute shear strength of concrete.
          -. Vuz       =     125.59 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1111.56 kN.
          -. phiVcz    = phi * Vcz =     1000.40 kN.

          -. Vuy       =     407.06 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1068.17 kN.
          -. phiVcy    = phi * Vcy =      961.35 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2048.74 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6036.93 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2048.74 kN.
          -. phiVsz   = phi*Vsz =     1843.87 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2020.26 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6080.32 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2020.26 kN.
          -. phiVsy   = phi*Vsy =     1818.24 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     425.992 kN.
          -. Vr       =    2779.590 kN.
          -. Ratio    = Vu / Vr = 0.153  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 473.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 473.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112222,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2229.34       273.58       224.76      1038.15       849.83
           ---------------------------------------------------------------------------
           DL+LL+Others    -2229.34       273.58       224.76      1038.15       849.83
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6367.400 kN.
          -. Mry        =       765.885 kN-m.
          -. Mrz        =      2941.681 kN-m.
          -. Mr         =      3039.748 kN-m.
          -. Pu/Pr      =   0.350  --->  O.K !
          -. Muy/Mry    =   0.357  --->  O.K !
          -. Muz/Mrz    =   0.353  --->  O.K !
          -. Mu/Mr      =   0.357  --->  O.K !
          -. Ratio      =   0.357  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5813.88 kN.
          -. Vuz    =        112.94 kN.
          -. Muy    =       -305.07 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.18 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.53
```

```
          -. Vuy    =       371.61 kN.
          -. Muz    =     -1004.36 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.53 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.44

     ( ). Compute shear strength of concrete.
          -. Vuz       =     112.94 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1143.46 kN.
          -. phiVcz    = phi * Vcz =     1029.11 kN.

          -. Vuy       =     371.61 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1100.12 kN.
          -. phiVcy    = phi * Vcy =      990.11 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2068.63 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6005.03 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2068.63 kN.
          -. phiVsz   = phi*Vsz =     1861.76 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2041.40 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6048.37 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2041.40 kN.
          -. phiVsy   = phi*Vsy =     1837.26 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     388.393 kN.
          -. Vr       =    2827.370 kN.
          -. Ratio    = Vu / Vr = 0.137  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 431.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 431.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0053 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0053 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112223,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2217.49       224.76       182.11       849.83       682.95
           ---------------------------------------------------------------------------
           DL+LL+Others    -2217.49       224.76       182.11       849.83       682.95
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7049.193 kN.
          -. Mry        =       707.513 kN-m.
          -. Mrz        =      2702.529 kN-m.
          -. Mr         =      2793.607 kN-m.
          -. Pu/Pr      =   0.315  --->  O.K !
          -. Muy/Mry    =   0.318  --->  O.K !
          -. Muz/Mrz    =   0.314  --->  O.K !
          -. Mu/Mr      =   0.318  --->  O.K !
          -. Ratio      =   0.318  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5830.68 kN.
          -. Vuz    =         98.66 kN.
          -. Muy    =       -251.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.60
```

```
          -. Vuy    =       327.68 kN.
          -. Muz    =      -818.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.27 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51

     ( ). Compute shear strength of concrete.
          -. Vuz       =      98.66 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1175.64 kN.
          -. phiVcz    = phi * Vcz =     1058.08 kN.

          -. Vuy       =     327.68 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1132.43 kN.
          -. phiVcy    = phi * Vcy =     1019.19 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2087.85 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5972.85 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2087.85 kN.
          -. phiVsz   = phi*Vsz =     1879.06 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2061.85 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6016.06 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2061.85 kN.
          -. phiVsy   = phi*Vsy =     1855.67 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     342.216 kN.
          -. Vr       =    2874.854 kN.
          -. Ratio    = Vu / Vr = 0.119  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 380.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 380.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0060 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0060 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0060 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112224,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2205.63       182.11       146.07       682.95       540.88
           ---------------------------------------------------------------------------
           DL+LL+Others    -2205.63       182.11       146.07       682.95       540.88
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7815.871 kN.
          -. Mry        =       660.595 kN-m.
          -. Mrz        =      2419.882 kN-m.
          -. Mr         =      2508.429 kN-m.
          -. Pu/Pr      =   0.282  --->  O.K !
          -. Muy/Mry    =   0.276  --->  O.K !
          -. Muz/Mrz    =   0.282  --->  O.K !
          -. Mu/Mr      =   0.282  --->  O.K !
          -. Ratio      =   0.282  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5847.47 kN.
          -. Vuz    =         83.28 kN.
          -. Muy    =       -204.89 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.67
```

```
          -. Vuy    =       277.61 kN.
          -. Muz    =      -655.11 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.58

     ( ). Compute shear strength of concrete.
          -. Vuz       =      83.28 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1206.99 kN.
          -. phiVcz    = phi * Vcz =     1086.29 kN.

          -. Vuy       =     277.61 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1163.98 kN.
          -. phiVcy    = phi * Vcy =     1047.58 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2105.81 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5941.50 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2105.81 kN.
          -. phiVsz   = phi*Vsz =     1895.23 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2080.98 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5984.51 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2080.98 kN.
          -. phiVsy   = phi*Vsy =     1872.88 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     289.831 kN.
          -. Vr       =    2920.461 kN.
          -. Ratio    = Vu / Vr = 0.099  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 322.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 322.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0067 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0067 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0067 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112225,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2193.77       146.07       114.85       540.88       417.08
           ---------------------------------------------------------------------------
           DL+LL+Others    -2193.77       146.07       114.85       540.88       417.08
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -8613.959 kN.
          -. Mry        =       570.412 kN-m.
          -. Mrz        =      2115.726 kN-m.
          -. Mr         =      2191.271 kN-m.
          -. Pu/Pr      =   0.255  --->  O.K !
          -. Muy/Mry    =   0.256  --->  O.K !
          -. Muz/Mrz    =   0.256  --->  O.K !
          -. Mu/Mr      =   0.256  --->  O.K !
          -. Ratio      =   0.256  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5864.26 kN.
          -. Vuz    =         72.42 kN.
          -. Muy    =       -165.01 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.54 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73
```

```
          -. Vuy    =       241.05 kN.
          -. Muz    =      -516.36 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64

     ( ). Compute shear strength of concrete.
          -. Vuz       =       72.42 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1233.85 kN.
          -. phiVcz    = phi * Vcz =     1110.47 kN.

          -. Vuy       =      241.05 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1191.07 kN.
          -. phiVcy    = phi * Vcy =     1071.96 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2120.63 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5914.64 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2120.63 kN.
          -. phiVsz   = phi*Vsz =     1908.57 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2096.78 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5957.42 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2096.78 kN.
          -. phiVsy   = phi*Vsy =     1887.10 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     251.694 kN.
          -. Vr       =    2959.061 kN.
          -. Ratio    = Vu / Vr = 0.085  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 279.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 279.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0072 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0072 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0072 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112226,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5897.69      -130.31      -100.35      -395.85      -292.03
           ------------------------------------------------------------------------------
            DL+LL+Others     5897.69      -130.31      -100.35      -395.85      -292.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      100.35 kN-m.
           -. End Moments (My2) =      130.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -100.35 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -100.35 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      292.03 kN-m.
          -. End Moments (Mz2) =      395.85 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -292.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -292.03 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       415.041 kN-m.
          -. Mrz        =      1208.489 kN-m.
          -. Mr         =      1277.773 kN-m.
          -. Pu/Pr      =   0.242  --->  O.K !
          -. Muy/Mry    =   0.242  --->  O.K !
          -. Muz/Mrz    =   0.242  --->  O.K !
          -. Mu/Mr      =   0.242  --->  O.K !
          -. Ratio      =   0.242  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5881.03 kN.
          -. Vuz    =         62.65 kN.
          -. Muy    =       -130.31 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.79

          -. Vuy    =        207.65 kN.
          -. Muz    =       -395.85 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69
```

( ). Compute shear strength of concrete.
-. Vuz = 62.65 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1258.25 kN.
-. phiVcz = phi * Vcz = 1132.43 kN.

-. Vuy = 207.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1215.72 kN.
-. phiVcy = phi * Vcy = 1094.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2133.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5890.23 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2133.67 kN.
-. phiVsz = phi*Vsz = 1920.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2110.68 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5932.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2110.68 kN.
-. phiVsy = phi*Vsy = 1899.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 216.898 kN.
-. Vr = 2993.768 kN.
-. Ratio = Vu / Vr = 0.072 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 241.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 241.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0077 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0077 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0077 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112227,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5914.46      -100.35       -75.05      -292.03      -204.62
           ------------------------------------------------------------------------------
            DL+LL+Others     5914.46      -100.35       -75.05      -292.03      -204.62
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       75.05 kN-m.
           -. End Moments (My2) =      100.35 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -75.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -75.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      204.62 kN-m.
          -. End Moments (Mz2) =      292.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -204.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -204.62 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       309.639 kN-m.
          -. Mrz        =       844.316 kN-m.
          -. Mr         =       899.303 kN-m.
          -. Pu/Pr      =   0.242  --->  O.K !
          -. Muy/Mry    =   0.242  --->  O.K !
          -. Muz/Mrz    =   0.242  --->  O.K !
          -. Mu/Mr      =   0.242  --->  O.K !
          -. Ratio      =   0.242  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5897.80 kN.
          -. Vuz    =         53.15 kN.
          -. Muy    =       -100.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.83

          -. Vuy    =        174.83 kN.
          -. Muz    =       -292.03 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 53.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1280.51 kN.
-. phiVcz = phi * Vcz = 1152.46 kN.

-. Vuy = 174.83 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1238.26 kN.
-. phiVcy = phi * Vcy = 1114.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2145.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5867.97 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2145.23 kN.
-. phiVsz = phi*Vsz = 1930.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5910.23 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.02 kN.
-. phiVsy = phi*Vsy = 1910.72 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 182.732 kN.
-. Vr = 3025.145 kN.
-. Ratio = Vu / Vr = 0.060 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 203.04 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 203.04 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0082 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0082 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0082 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112228,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          5931.22       -75.05       -54.21      -204.62      -132.94
           ---------------------------------------------------------------------------
            DL+LL+Others    5931.22       -75.05       -54.21      -204.62      -132.94
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       54.21 kN-m.
           -. End Moments (My2) =       75.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -54.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -54.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      132.94 kN-m.
          -. End Moments (Mz2) =      204.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -132.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -132.94 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       223.636 kN-m.
          -. Mrz        =       546.757 kN-m.
          -. Mr         =       590.726 kN-m.
          -. Pu/Pr      =   0.243  --->  O.K !
          -. Muy/Mry    =   0.242  --->  O.K !
          -. Muz/Mrz    =   0.243  --->  O.K !
          -. Mu/Mr      =   0.243  --->  O.K !
          -. Ratio      =   0.243  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5914.57 kN.
          -. Vuz    =         44.09 kN.
          -. Muy    =        -75.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.12 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        143.37 kN.
          -. Muz    =       -204.62 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.79
```

( ). Compute shear strength of concrete.
-. Vuz = 44.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1300.28 kN.
-. phiVcz = phi * Vcz = 1170.25 kN.

-. Vuy = 143.37 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1258.29 kN.
-. phiVcy = phi * Vcy = 1132.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2155.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5848.21 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2155.23 kN.
-. phiVsz = phi*Vsz = 1939.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2133.70 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5890.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2133.70 kN.
-. phiVsy = phi*Vsy = 1920.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 149.996 kN.
-. Vr = 3052.787 kN.
-. Ratio = Vu / Vr = 0.049 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 166.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 166.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0085 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0085 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0085 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112229,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5947.98       -54.21       -37.54      -132.94       -76.03
           ------------------------------------------------------------------------------
            DL+LL+Others     5947.98       -54.21       -37.54      -132.94       -76.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       37.54 kN-m.
           -. End Moments (My2) =       54.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -37.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -37.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       76.03 kN-m.
          -. End Moments (Mz2) =      132.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -76.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -76.03 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       154.183 kN-m.
          -. Mrz        =       311.885 kN-m.
          -. Mr         =       347.914 kN-m.
          -. Pu/Pr      =   0.244  --->  O.K !
          -. Muy/Mry    =   0.243  --->  O.K !
          -. Muz/Mrz    =   0.244  --->  O.K !
          -. Mu/Mr      =   0.244  --->  O.K !
          -. Ratio      =   0.244  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5931.32 kN.
          -. Vuz    =         35.64 kN.
          -. Muy    =        -54.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.02 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.92

          -. Vuy    =        113.86 kN.
          -. Muz    =       -132.94 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.27 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.82
```

( ). Compute shear strength of concrete.
-. Vuz = 35.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1317.29 kN.
-. phiVcz = phi * Vcz = 1185.56 kN.

-. Vuy = 113.86 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1275.57 kN.
-. phiVcy = phi * Vcy = 1148.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2163.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5831.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2163.66 kN.
-. phiVsz = phi*Vsz = 1947.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2142.69 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5872.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2142.69 kN.
-. phiVsy = phi*Vsy = 1928.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 119.313 kN.
-. Vr = 3076.431 kN.
-. Ratio = Vu / Vr = 0.039 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 132.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 132.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0089 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0089 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0089 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112230,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5964.72       -37.54       -25.92       -76.03       -32.72
           ------------------------------------------------------------------------------
            DL+LL+Others     5964.72       -37.54       -25.92       -76.03       -32.72
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       25.92 kN-m.
           -. End Moments (My2) =       37.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -25.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -25.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       32.72 kN-m.
          -. End Moments (Mz2) =       76.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -32.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -32.72 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       105.962 kN-m.
          -. Mrz        =       133.930 kN-m.
          -. Mr         =       170.779 kN-m.
          -. Pu/Pr      =   0.244  --->  O.K !
          -. Muy/Mry    =   0.245  --->  O.K !
          -. Muz/Mrz    =   0.244  --->  O.K !
          -. Mu/Mr      =   0.245  --->  O.K !
          -. Ratio      =   0.245  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5964.72 kN.
          -. Vuz    =         27.92 kN.
          -. Muy    =        -25.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =         86.76 kN.
          -. Muz    =        -32.72 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.85
```

( ). Compute shear strength of concrete.
-. Vuz = 27.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1331.20 kN.
-. phiVcz = phi * Vcz = 1198.08 kN.

-. Vuy = 86.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1289.70 kN.
-. phiVcy = phi * Vcy = 1160.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2170.41 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5817.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2170.41 kN.
-. phiVsz = phi*Vsz = 1953.37 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2149.91 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5858.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2149.91 kN.
-. phiVsy = phi*Vsy = 1934.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 91.138 kN.
-. Vr = 3095.645 kN.
-. Ratio = Vu / Vr = 0.029 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 101.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 101.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0093 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0093 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0093 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112231,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5981.46       -25.92       -24.91       -32.72        -1.96
           ------------------------------------------------------------------------------
            DL+LL+Others     5981.46       -25.92       -24.91       -32.72        -1.96
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       24.91 kN-m.
           -. End Moments (My2) =       25.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -24.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -24.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.96 kN-m.
          -. End Moments (Mz2) =       32.72 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.96 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.96 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       101.607 kN-m.
          -. Mrz        =         8.113 kN-m.
          -. Mr         =       101.930 kN-m.
          -. Pu/Pr      =   0.245  --->  O.K !
          -. Muy/Mry    =   0.245  --->  O.K !
          -. Muz/Mrz    =   0.241  --->  O.K !
          -. Mu/Mr      =   0.245  --->  O.K !
          -. Ratio      =   0.245  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5981.46 kN.
          -. Vuz    =         21.01 kN.
          -. Muy    =        -24.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96

          -. Vuy    =         62.34 kN.
          -. Muz    =         -1.96 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 21.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1338.11 kN.
-. phiVcz = phi * Vcz = 1204.30 kN.

-. Vuy = 62.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1296.72 kN.
-. phiVcy = phi * Vcy = 1167.05 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2173.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5810.38 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2173.73 kN.
-. phiVsz = phi*Vsz = 1956.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2153.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5851.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2153.45 kN.
-. phiVsy = phi*Vsy = 1938.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 65.790 kN.
-. Vr = 3105.162 kN.
-. Ratio = Vu / Vr = 0.021 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 73.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 73.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0094 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0094 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0094 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112232,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5998.19       -24.91       -23.47        -1.96       -16.81
           ------------------------------------------------------------------------------
            DL+LL+Others     5998.19       -24.91       -23.47        -1.96       -16.81
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       23.47 kN-m.
           -. End Moments (My2) =       24.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -23.47 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -23.47 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.96 kN-m.
          -. End Moments (Mz2) =       16.81 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -16.81 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -16.81 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        95.518 kN-m.
          -. Mrz        =        68.389 kN-m.
          -. Mr         =       117.477 kN-m.
          -. Pu/Pr      =   0.246  --->  O.K !
          -. Muy/Mry    =   0.246  --->  O.K !
          -. Muz/Mrz    =   0.246  --->  O.K !
          -. Mu/Mr      =   0.246  --->  O.K !
          -. Ratio      =   0.246  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5998.19 kN.
          -. Vuz    =         14.99 kN.
          -. Muy    =        -23.47 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98

          -. Vuy    =         40.82 kN.
          -. Muz    =        -16.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 14.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1344.08 kN.
-. phiVcz = phi * Vcz = 1209.67 kN.

-. Vuy = 40.82 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1302.80 kN.
-. phiVcy = phi * Vcy = 1172.52 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2176.57 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5804.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2176.57 kN.
-. phiVsz = phi*Vsz = 1958.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2156.50 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5845.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2156.50 kN.
-. phiVsy = phi*Vsy = 1940.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 43.488 kN.
-. Vr = 3113.370 kN.
-. Ratio = Vu / Vr = 0.014 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 48.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 48.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0095 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0095 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0095 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112233,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6014.92       -23.47       -21.21       -16.81       -28.48
           ------------------------------------------------------------------------------
            DL+LL+Others     6014.92       -23.47       -21.21       -16.81       -28.48
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       21.21 kN-m.
           -. End Moments (My2) =       23.47 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -21.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -21.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       16.81 kN-m.
          -. End Moments (Mz2) =       28.48 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -28.48 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -28.48 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        86.206 kN-m.
          -. Mrz        =       115.458 kN-m.
          -. Mr         =       144.090 kN-m.
          -. Pu/Pr      =   0.246  --->  O.K !
          -. Muy/Mry    =   0.246  --->  O.K !
          -. Muz/Mrz    =   0.247  --->  O.K !
          -. Mu/Mr      =   0.247  --->  O.K !
          -. Ratio      =   0.247  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6014.92 kN.
          -. Vuz    =          9.90 kN.
          -. Muy    =        -21.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98

          -. Vuy    =         22.31 kN.
          -. Muz    =        -28.48 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.09 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.89
```

( ). Compute shear strength of concrete.
-. Vuz = 9.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1346.25 kN.
-. phiVcz = phi * Vcz = 1211.63 kN.

-. Vuy = 22.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1305.02 kN.
-. phiVcy = phi * Vcy = 1174.51 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2177.60 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5802.23 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2177.60 kN.
-. phiVsz = phi*Vsz = 1959.84 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2157.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5843.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2157.60 kN.
-. phiVsy = phi*Vsy = 1941.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 24.408 kN.
-. Vr = 3116.352 kN.
-. Ratio = Vu / Vr = 0.008 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 27.12 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 27.12 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0095 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0095 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0095 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112234,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6031.64       -21.21       -18.75       -28.48       -36.06
           ------------------------------------------------------------------------------
            DL+LL+Others     6031.64       -21.21       -18.75       -28.48       -36.06
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       18.75 kN-m.
           -. End Moments (My2) =       21.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -18.75 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -18.75 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       28.48 kN-m.
          -. End Moments (Mz2) =       36.06 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -36.06 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -36.06 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        76.023 kN-m.
          -. Mrz        =       145.802 kN-m.
          -. Mr         =       164.432 kN-m.
          -. Pu/Pr      =   0.247  --->  O.K !
          -. Muy/Mry    =   0.247  --->  O.K !
          -. Muz/Mrz    =   0.247  --->  O.K !
          -. Mu/Mr      =   0.247  --->  O.K !
          -. Ratio      =   0.247  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6031.64 kN.
          -. Vuz    =          7.65 kN.
          -. Muy    =        -18.75 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98

          -. Vuy    =         13.94 kN.
          -. Muz    =        -36.06 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.09 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.89
```

( ). Compute shear strength of concrete.
-. Vuz = 7.65 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1345.29 kN.
-. phiVcz = phi * Vcz = 1210.76 kN.

-. Vuy = 13.94 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1304.04 kN.
-. phiVcy = phi * Vcy = 1173.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2177.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5803.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2177.15 kN.
-. phiVsz = phi*Vsz = 1959.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2157.11 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5844.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2157.11 kN.
-. phiVsy = phi*Vsy = 1941.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.903 kN.
-. Vr = 3115.034 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0096 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0096 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0096 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112235,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6048.34       -18.75       -16.41       -36.06       -40.27
           ------------------------------------------------------------------------------
            DL+LL+Others     6048.34       -18.75       -16.41       -36.06       -40.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       16.41 kN-m.
           -. End Moments (My2) =       18.75 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -16.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -16.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       36.06 kN-m.
          -. End Moments (Mz2) =       40.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -40.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -40.27 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        66.383 kN-m.
          -. Mrz        =       162.407 kN-m.
          -. Mr         =       175.450 kN-m.
          -. Pu/Pr      =   0.248  --->  O.K !
          -. Muy/Mry    =   0.247  --->  O.K !
          -. Muz/Mrz    =   0.248  --->  O.K !
          -. Mu/Mr      =   0.248  --->  O.K !
          -. Ratio      =   0.248  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6048.34 kN.
          -. Vuz    =          6.32 kN.
          -. Muy    =        -16.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98

          -. Vuy    =          7.38 kN.
          -. Muz    =        -40.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 6.32 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1344.39 kN.
-. phiVcz = phi * Vcz = 1209.95 kN.

-. Vuy = 7.38 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1303.12 kN.
-. phiVcy = phi * Vcy = 1172.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2176.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5804.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2176.72 kN.
-. phiVsz = phi*Vsz = 1959.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2156.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5845.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2156.65 kN.
-. phiVsy = phi*Vsy = 1940.99 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 9.717 kN.
-. Vr = 3113.792 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0096 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0096 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0096 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112236,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6065.05       -16.41       -13.38       -40.27       -37.50
           ------------------------------------------------------------------------------
            DL+LL+Others     6065.05       -16.41       -13.38       -40.27       -37.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.38 kN-m.
           -. End Moments (My2) =       16.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       37.50 kN-m.
          -. End Moments (Mz2) =       40.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -37.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -37.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =        53.803 kN-m.
           -. Mrz        =       150.895 kN-m.
           -. Mr         =       160.200 kN-m.
           -. Pu/Pr      =   0.249  --->  O.K !
           -. Muy/Mry    =   0.249  --->  O.K !
           -. Muz/Mrz    =   0.248  --->  O.K !
           -. Mu/Mr      =   0.249  --->  O.K !
           -. Ratio      =   0.249  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       4349.73 kN.
           -. Vuz    =          9.58 kN.
           -. Muy    =        -28.66 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.06 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.33

           -. Vuy    =          2.31 kN.
           -. Muz    =        -17.51 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.23 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 9.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1503.88 kN.
-. phiVcz = phi * Vcz = 1353.49 kN.

-. Vuy = 2.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1466.42 kN.
-. phiVcy = phi * Vcy = 1319.78 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2245.92 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5644.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2245.92 kN.
-. phiVsz = phi*Vsz = 2021.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2230.76 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5682.07 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2230.76 kN.
-. phiVsy = phi*Vsy = 2007.68 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 9.853 kN.
-. Vr = 3327.460 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0069 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0069 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0069 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112237,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6081.74       -13.38        -9.92       -37.50       -30.14
           ---------------------------------------------------------------------------
            DL+LL+Others     6081.74       -13.38        -9.92       -37.50       -30.14
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        9.92 kN-m.
           -. End Moments (My2) =       13.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -9.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -9.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       30.14 kN-m.
          -. End Moments (Mz2) =       37.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -30.14 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -30.14 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        39.797 kN-m.
          -. Mrz        =       120.939 kN-m.
          -. Mr         =       127.319 kN-m.
          -. Pu/Pr      =   0.249  --->  O.K !
          -. Muy/Mry    =   0.249  --->  O.K !
          -. Muz/Mrz    =   0.249  --->  O.K !
          -. Mu/Mr      =   0.249  --->  O.K !
          -. Ratio      =   0.249  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6065.08 kN.
          -. Vuz    =          7.18 kN.
          -. Muy    =        -13.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97

          -. Vuy    =         14.72 kN.
          -. Muz    =        -37.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 7.18 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1342.60 kN.
-. phiVcz = phi * Vcz = 1208.34 kN.

-. Vuy = 14.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1301.30 kN.
-. phiVcy = phi * Vcy = 1171.17 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2175.87 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5805.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2175.87 kN.
-. phiVsz = phi*Vsz = 1958.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2155.75 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5847.19 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2155.75 kN.
-. phiVsy = phi*Vsy = 1940.17 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 16.378 kN.
-. Vr = 3111.343 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 18.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 18.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0096 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0096 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0096 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112238,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6098.43        -9.92        -6.39       -30.14       -20.50
           ------------------------------------------------------------------------------
            DL+LL+Others     6098.43        -9.92        -6.39       -30.14       -20.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        6.39 kN-m.
           -. End Moments (My2) =        9.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -6.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -6.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       20.50 kN-m.
          -. End Moments (Mz2) =       30.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -20.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -20.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        25.597 kN-m.
          -. Mrz        =        82.020 kN-m.
          -. Mr         =        85.922 kN-m.
          -. Pu/Pr      =   0.250  --->  O.K !
          -. Muy/Mry    =   0.250  --->  O.K !
          -. Muz/Mrz    =   0.250  --->  O.K !
          -. Mu/Mr      =   0.250  --->  O.K !
          -. Ratio      =   0.250  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6081.77 kN.
          -. Vuz    =          7.13 kN.
          -. Muy    =         -9.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97

          -. Vuy    =         19.29 kN.
          -. Muz    =        -30.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 7.13 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1342.08 kN.
-. phiVcz = phi * Vcz = 1207.87 kN.

-. Vuy = 19.29 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1300.77 kN.
-. phiVcy = phi * Vcy = 1170.69 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2175.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5806.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2175.62 kN.
-. phiVsz = phi*Vsz = 1958.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2155.48 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5847.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2155.48 kN.
-. phiVsy = phi*Vsy = 1939.93 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 20.566 kN.
-. Vr = 3110.623 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 22.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 22.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0097 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0097 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0097 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112239,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6115.10        -6.39        -3.24       -20.50       -10.80
           ---------------------------------------------------------------------------
            DL+LL+Others     6115.10        -6.39        -3.24       -20.50       -10.80
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.24 kN-m.
           -. End Moments (My2) =        6.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.24 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.24 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       10.80 kN-m.
          -. End Moments (Mz2) =       20.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -10.80 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -10.80 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        12.958 kN-m.
          -. Mrz        =        43.112 kN-m.
          -. Mr         =        45.017 kN-m.
          -. Pu/Pr      =   0.251  --->  O.K !
          -. Muy/Mry    =   0.250  --->  O.K !
          -. Muz/Mrz    =   0.251  --->  O.K !
          -. Mu/Mr      =   0.251  --->  O.K !
          -. Ratio      =   0.251  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6115.10 kN.
          -. Vuz    =          6.33 kN.
          -. Muy    =         -3.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97

          -. Vuy    =         19.39 kN.
          -. Muz    =        -10.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 6.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1342.05 kN.
-. phiVcz = phi * Vcz = 1207.85 kN.

-. Vuy = 19.39 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1300.74 kN.
-. phiVcy = phi * Vcy = 1170.66 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2175.61 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5806.43 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2175.61 kN.
-. phiVsz = phi*Vsz = 1958.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2155.47 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5847.75 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2155.47 kN.
-. phiVsy = phi*Vsy = 1939.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 20.396 kN.
-. Vr = 3110.584 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 22.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 22.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0098 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0098 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0098 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112240,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6131.78        -3.24        -0.94       -10.80        -3.25
           ------------------------------------------------------------------------------
            DL+LL+Others     6131.78        -3.24        -0.94       -10.80        -3.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.94 kN-m.
           -. End Moments (My2) =        3.24 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.94 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.94 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.25 kN-m.
          -. End Moments (Mz2) =       10.80 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.25 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         3.762 kN-m.
          -. Mrz        =        12.923 kN-m.
          -. Mr         =        13.459 kN-m.
          -. Pu/Pr      =   0.251  --->  O.K !
          -. Muy/Mry    =   0.251  --->  O.K !
          -. Muz/Mrz    =   0.251  --->  O.K !
          -. Mu/Mr      =   0.251  --->  O.K !
          -. Ratio      =   0.251  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6131.78 kN.
          -. Vuz    =          4.61 kN.
          -. Muy    =         -0.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97

          -. Vuy    =         15.11 kN.
          -. Muz    =         -3.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 4.61 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1342.19 kN.
-. phiVcz = phi * Vcz = 1207.97 kN.

-. Vuy = 15.11 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1300.88 kN.
-. phiVcy = phi * Vcy = 1170.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2175.68 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5806.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2175.68 kN.
-. phiVsz = phi*Vsz = 1958.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2155.54 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5847.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2155.54 kN.
-. phiVsy = phi*Vsy = 1939.98 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.800 kN.
-. Vr = 3110.778 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0098 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0098 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0098 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112241,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           6148.44        -0.94         0.00        -3.25         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     6148.44        -0.94         0.00        -3.25         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.94 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y             =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        3.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z             =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.252  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.252  --->  O.K !
          -. Ratio      =   0.252  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       6148.44 kN.
          -. Vuz    =          1.89 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =          6.49 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 1.89 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1302.52 kN.
-. phiVcz = phi * Vcz = 1172.27 kN.

-. Vuy = 6.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1302.52 kN.
-. phiVcy = phi * Vcy = 1172.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2156.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5845.96 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2156.36 kN.
-. phiVsz = phi*Vsz = 1940.72 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2156.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5845.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2156.36 kN.
-. phiVsy = phi*Vsy = 1940.72 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 6.763 kN.
-. Vr = 3112.990 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 7.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 7.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0099 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0099 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0099 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113002,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            839.99       292.11       357.45      2418.60      2545.56
           ------------------------------------------------------------------------------
            DL+LL+Others      839.99       292.11       357.45      2418.60      2545.56
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      292.11 kN-m.
           -. End Moments (My2) =      357.45 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      357.45 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      357.45 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2418.60 kN-m.
          -. End Moments (Mz2) =     2545.56 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2545.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2545.56 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =      1667.684 kN.
           -. Mry        =       715.689 kN-m.
           -. Mrz        =      5057.524 kN-m.
           -. Mr         =      5107.911 kN-m.
           -. Pu/Pr      =   0.504  --->  O.K !
           -. Muy/Mry    =   0.499  --->  O.K !
           -. Muz/Mrz    =   0.503  --->  O.K !
           -. Mu/Mr      =   0.504  --->  O.K !
           -. Ratio      =   0.504  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2638.33 kN.
           -. Vuz    =        210.22 kN.
           -. Muy    =       -363.03 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  33.31 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.50

           -. Vuy    =        336.11 kN.
           -. Muz    =      -2505.82 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  33.67 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.40
```

( ). Compute shear strength of concrete.
-. Vuz = 210.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1127.40 kN.
-. phiVcz = phi * Vcz = 1014.66 kN.

-. Vuy = 336.11 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1084.03 kN.
-. phiVcy = phi * Vcy = 975.62 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2058.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6021.09 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2058.72 kN.
-. phiVsz = phi*Vsz = 1852.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2030.87 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6064.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2030.87 kN.
-. phiVsy = phi*Vsy = 1827.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 396.432 kN.
-. Vr = 2803.409 kN.
-. Ratio = Vu / Vr = 0.141 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 440.48 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 440.48 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113003,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            851.96       357.45       429.97      2545.56      2647.03
           ---------------------------------------------------------------------------
            DL+LL+Others      851.96       357.45       429.97      2545.56      2647.03
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      357.45 kN-m.
           -. End Moments (My2) =      429.97 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      429.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      429.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2545.56 kN-m.
          -. End Moments (Mz2) =     2647.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2647.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2647.03 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1626.658 kN.
          -. Mry        =       821.304 kN-m.
          -. Mrz        =      5038.271 kN-m.
          -. Mr         =      5104.774 kN-m.
          -. Pu/Pr      =   0.524  --->  O.K !
          -. Muy/Mry    =   0.524  --->  O.K !
          -. Muz/Mrz    =   0.525  --->  O.K !
          -. Mu/Mr      =   0.525  --->  O.K !
          -. Ratio      =   0.525  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2655.01 kN.
          -. Vuz    =        190.71 kN.
          -. Muy    =       -436.25 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47

          -. Vuy    =        282.62 kN.
          -. Muz    =      -2610.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 190.71 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1117.47 kN.
-. phiVcz = phi * Vcz = 1005.72 kN.

-. Vuy = 282.62 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1074.08 kN.
-. phiVcy = phi * Vcy = 966.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2052.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6031.02 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2052.49 kN.
-. phiVsz = phi*Vsz = 1847.24 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2024.25 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6074.40 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2024.25 kN.
-. phiVsy = phi*Vsy = 1821.82 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 340.949 kN.
-. Vr = 2788.499 kN.
-. Ratio = Vu / Vr = 0.122 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 378.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 378.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113004,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            863.93       429.97       501.64      2647.03      2724.69
           ---------------------------------------------------------------------------
            DL+LL+Others      863.93       429.97       501.64      2647.03      2724.69
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      429.97 kN-m.
           -. End Moments (My2) =      501.64 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      501.64 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      501.64 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2647.03 kN-m.
          -. End Moments (Mz2) =     2724.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2724.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2724.69 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1582.888 kN.
          -. Mry        =       924.247 kN-m.
          -. Mrz        =      5016.836 kN-m.
          -. Mr         =      5101.262 kN-m.
          -. Pu/Pr      =   0.546  --->  O.K !
          -. Muy/Mry    =   0.543  --->  O.K !
          -. Muz/Mrz    =   0.543  --->  O.K !
          -. Mu/Mr      =   0.546  --->  O.K !
          -. Ratio      =   0.546  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2655.60 kN.
          -. Vuz    =        292.61 kN.
          -. Muy    =      -1099.31 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81

          -. Vuy    =        121.28 kN.
          -. Muz    =      -1247.85 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 292.61 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1268.56 kN.
-. phiVcz = phi * Vcz = 1141.70 kN.

-. Vuy = 121.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1226.15 kN.
-. phiVcy = phi * Vcy = 1103.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2139.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5879.93 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2139.06 kN.
-. phiVsz = phi*Vsz = 1925.16 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2116.43 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5922.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2116.43 kN.
-. phiVsy = phi*Vsy = 1904.79 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 316.749 kN.
-. Vr = 3008.325 kN.
-. Ratio = Vu / Vr = 0.105 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 351.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 351.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113005,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            875.89       501.64       560.74      2724.69      2760.99
           ------------------------------------------------------------------------------
            DL+LL+Others      875.89       501.64       560.74      2724.69      2760.99
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      501.64 kN-m.
           -. End Moments (My2) =      560.74 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      560.74 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      560.74 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2724.69 kN-m.
          -. End Moments (Mz2) =     2760.99 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2760.99 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2760.99 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1582.469 kN.
          -. Mry        =      1014.226 kN-m.
          -. Mrz        =      4999.375 kN-m.
          -. Mr         =      5101.215 kN-m.
          -. Pu/Pr      =   0.553  --->  O.K !
          -. Muy/Mry    =   0.553  --->  O.K !
          -. Muz/Mrz    =   0.552  --->  O.K !
          -. Mu/Mr      =   0.553  --->  O.K !
          -. Ratio      =   0.553  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2672.28 kN.
          -. Vuz    =        230.26 kN.
          -. Muy    =      -1207.66 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.34 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =         86.10 kN.
          -. Muz    =      -1257.32 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.70
```

( ). Compute shear strength of concrete.
-. Vuz = 230.26 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1264.08 kN.
-. phiVcz = phi * Vcz = 1137.68 kN.

-. Vuy = 86.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1221.62 kN.
-. phiVcy = phi * Vcy = 1099.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2136.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5884.40 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2136.73 kN.
-. phiVsz = phi*Vsz = 1923.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2113.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5926.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2113.95 kN.
-. phiVsy = phi*Vsy = 1902.55 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 245.833 kN.
-. Vr = 3002.015 kN.
-. Ratio = Vu / Vr = 0.082 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 273.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 273.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113006,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            887.86       560.74       604.94      2760.99      2754.77
           ---------------------------------------------------------------------------
            DL+LL+Others      887.86       560.74       604.94      2760.99      2754.77
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      560.74 kN-m.
           -. End Moments (My2) =      604.94 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      604.94 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      604.94 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2754.77 kN-m.
          -. End Moments (Mz2) =     2760.99 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2754.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2754.77 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1603.461 kN.
          -. Mry        =      1091.853 kN-m.
          -. Mrz        =      4984.721 kN-m.
          -. Mr         =      5102.900 kN-m.
          -. Pu/Pr      =   0.554  --->  O.K !
          -. Muy/Mry    =   0.554  --->  O.K !
          -. Muz/Mrz    =   0.553  --->  O.K !
          -. Mu/Mr      =   0.554  --->  O.K !
          -. Ratio      =   0.554  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2688.97 kN.
          -. Vuz    =        164.68 kN.
          -. Muy    =      -1284.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =         59.85 kN.
          -. Muz    =      -1248.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 164.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1265.07 kN.
-. phiVcz = phi * Vcz = 1138.57 kN.

-. Vuy = 59.85 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1222.62 kN.
-. phiVcy = phi * Vcy = 1100.36 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2137.25 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5883.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2137.25 kN.
-. phiVsz = phi*Vsz = 1923.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2114.50 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5925.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2114.50 kN.
-. phiVsy = phi*Vsy = 1903.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 175.217 kN.
-. Vr = 3003.411 kN.
-. Ratio = Vu / Vr = 0.058 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 194.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 194.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113007,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            887.84       604.94       634.81      2754.77      2708.27
           ------------------------------------------------------------------------------
            DL+LL+Others      887.84       604.94       634.81      2754.77      2708.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      604.94 kN-m.
           -. End Moments (My2) =      634.81 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      604.94 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      604.94 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2708.27 kN-m.
          -. End Moments (Mz2) =     2754.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2754.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2754.77 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1603.461 kN.
          -. Mry        =      1091.853 kN-m.
          -. Mrz        =      4984.721 kN-m.
          -. Mr         =      5102.900 kN-m.
          -. Pu/Pr      =   0.554  --->  O.K !
          -. Muy/Mry    =   0.554  --->  O.K !
          -. Muz/Mrz    =   0.553  --->  O.K !
          -. Mu/Mr      =   0.554  --->  O.K !
          -. Ratio      =   0.554  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2705.07 kN.
          -. Vuz    =         71.10 kN.
          -. Muy    =       -612.53 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.48

          -. Vuy    =        105.50 kN.
          -. Muz    =      -2728.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.74 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 71.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1119.24 kN.
-. phiVcz = phi * Vcz = 1007.31 kN.

-. Vuy = 105.50 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1075.86 kN.
-. phiVcy = phi * Vcy = 968.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2053.61 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6029.25 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2053.61 kN.
-. phiVsz = phi*Vsz = 1848.25 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2025.43 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6072.63 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2025.43 kN.
-. phiVsy = phi*Vsy = 1822.89 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 127.219 kN.
-. Vr = 2791.162 kN.
-. Ratio = Vu / Vr = 0.046 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 141.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 141.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113008,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            899.81       634.81       650.61      2708.27      2624.11
           ---------------------------------------------------------------------------
            DL+LL+Others      899.81       634.81       650.61      2708.27      2624.11
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      634.81 kN-m.
           -. End Moments (My2) =      650.61 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      634.81 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      634.81 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2624.11 kN-m.
          -. End Moments (Mz2) =     2708.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2708.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2708.27 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1646.311 kN.
          -. Mry        =      1160.834 kN-m.
          -. Mrz        =      4972.634 kN-m.
          -. Mr         =      5106.332 kN-m.
          -. Pu/Pr      =   0.547  --->  O.K !
          -. Muy/Mry    =   0.547  --->  O.K !
          -. Muz/Mrz    =   0.545  --->  O.K !
          -. Mu/Mr      =   0.547  --->  O.K !
          -. Ratio      =   0.547  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2721.75 kN.
          -. Vuz    =         39.21 kN.
          -. Muy    =       -642.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47

          -. Vuy    =        169.44 kN.
          -. Muz    =      -2685.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 39.21 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1117.63 kN.
-. phiVcz = phi * Vcz = 1005.87 kN.

-. Vuy = 169.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1074.24 kN.
-. phiVcy = phi * Vcy = 966.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2052.59 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6030.86 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2052.59 kN.
-. phiVsz = phi*Vsz = 1847.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2024.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6074.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2024.36 kN.
-. phiVsy = phi*Vsy = 1821.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 173.922 kN.
-. Vr = 2788.740 kN.
-. Ratio = Vu / Vr = 0.062 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 193.25 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 193.25 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113009,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            911.78       650.61       651.97      2624.11      2505.22
           ------------------------------------------------------------------------------
            DL+LL+Others      911.78       650.61       651.97      2624.11      2505.22
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      650.61 kN-m.
           -. End Moments (My2) =      651.97 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      650.61 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      650.61 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2505.22 kN-m.
          -. End Moments (Mz2) =     2624.11 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2624.11 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2624.11 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1719.440 kN.
          -. Mry        =      1226.570 kN-m.
          -. Mrz        =      4961.120 kN-m.
          -. Mr         =      5110.498 kN-m.
          -. Pu/Pr      =   0.530  --->  O.K !
          -. Muy/Mry    =   0.530  --->  O.K !
          -. Muz/Mrz    =   0.529  --->  O.K !
          -. Mu/Mr      =   0.530  --->  O.K !
          -. Ratio      =   0.530  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2738.42 kN.
          -. Vuz    =         26.07 kN.
          -. Muy    =       -658.27 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.48

          -. Vuy    =        235.26 kN.
          -. Muz    =      -2604.37 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.74 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 26.07 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1119.43 kN.
-. phiVcz = phi * Vcz = 1007.49 kN.

-. Vuy = 235.26 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1076.05 kN.
-. phiVcy = phi * Vcy = 968.44 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2053.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6029.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2053.73 kN.
-. phiVsz = phi*Vsz = 1848.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2025.56 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6072.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2025.56 kN.
-. phiVsy = phi*Vsy = 1823.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 236.701 kN.
-. Vr = 2791.450 kN.
-. Ratio = Vu / Vr = 0.085 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 263.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 263.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113010,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            923.76       651.97       653.87      2505.22      2387.12
           ------------------------------------------------------------------------------
            DL+LL+Others      923.76       651.97       653.87      2505.22      2387.12
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      651.97 kN-m.
           -. End Moments (My2) =      653.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      651.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      651.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2387.12 kN-m.
          -. End Moments (Mz2) =     2505.22 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2505.22 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2505.22 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1821.547 kN.
          -. Mry        =      1288.798 kN-m.
          -. Mrz        =      4950.540 kN-m.
          -. Mr         =      5115.550 kN-m.
          -. Pu/Pr      =   0.507  --->  O.K !
          -. Muy/Mry    =   0.506  --->  O.K !
          -. Muz/Mrz    =   0.506  --->  O.K !
          -. Mu/Mr      =   0.507  --->  O.K !
          -. Ratio      =   0.507  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2755.10 kN.
          -. Vuz    =         25.76 kN.
          -. Muy    =       -659.45 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51

          -. Vuy    =        234.10 kN.
          -. Muz    =      -2488.33 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41
```

( ). Compute shear strength of concrete.
-. Vuz = 25.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1133.68 kN.
-. phiVcz = phi * Vcz = 1020.31 kN.

-. Vuy = 234.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1090.32 kN.
-. phiVcy = phi * Vcy = 981.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2062.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6014.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2062.62 kN.
-. phiVsz = phi*Vsz = 1856.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2035.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6058.17 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2035.02 kN.
-. phiVsy = phi*Vsy = 1831.52 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 235.516 kN.
-. Vr = 2812.805 kN.
-. Ratio = Vu / Vr = 0.084 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 261.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 261.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113011,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            935.73       653.87       656.24      2387.12      2269.70
           ---------------------------------------------------------------------------
            DL+LL+Others      935.73       653.87       656.24      2387.12      2269.70
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      653.87 kN-m.
           -. End Moments (My2) =      656.24 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      653.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      653.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2269.70 kN-m.
          -. End Moments (Mz2) =     2387.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2387.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2387.12 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1922.001 kN.
          -. Mry        =      1356.406 kN-m.
          -. Mrz        =      4937.485 kN-m.
          -. Mr         =      5120.410 kN-m.
          -. Pu/Pr      =   0.487  --->  O.K !
          -. Muy/Mry    =   0.482  --->  O.K !
          -. Muz/Mrz    =   0.483  --->  O.K !
          -. Mu/Mr      =   0.487  --->  O.K !
          -. Ratio      =   0.487  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2771.78 kN.
          -. Vuz    =         25.52 kN.
          -. Muy    =       -661.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.54

          -. Vuy    =        233.18 kN.
          -. Muz    =      -2373.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.45
```

( ). Compute shear strength of concrete.
-. Vuz = 25.52 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1148.09 kN.
-. phiVcz = phi * Vcz = 1033.29 kN.

-. Vuy = 233.18 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1104.77 kN.
-. phiVcy = phi * Vcy = 994.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2071.45 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6000.39 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2071.45 kN.
-. phiVsz = phi*Vsz = 1864.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2044.40 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6043.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2044.40 kN.
-. phiVsy = phi*Vsy = 1839.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 234.574 kN.
-. Vr = 2834.255 kN.
-. Ratio = Vu / Vr = 0.083 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 260.64 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 260.64 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113012,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            947.70       656.24       659.02      2269.70      2155.42
           ---------------------------------------------------------------------------
            DL+LL+Others      947.70       656.24       659.02      2269.70      2155.42
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      656.24 kN-m.
           -. End Moments (My2) =      659.02 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      656.24 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      656.24 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2155.42 kN-m.
          -. End Moments (Mz2) =     2269.70 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2269.70 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2269.70 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2049.899 kN.
          -. Mry        =      1421.651 kN-m.
          -. Mrz        =      4931.584 kN-m.
          -. Mr         =      5132.408 kN-m.
          -. Pu/Pr      =   0.462  --->  O.K !
          -. Muy/Mry    =   0.462  --->  O.K !
          -. Muz/Mrz    =   0.460  --->  O.K !
          -. Mu/Mr      =   0.462  --->  O.K !
          -. Ratio      =   0.462  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2788.45 kN.
          -. Vuz    =         25.32 kN.
          -. Muy    =       -663.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.04 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.57

          -. Vuy    =        232.47 kN.
          -. Muz    =      -2258.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.37 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48
```

( ). Compute shear strength of concrete.
-. Vuz = 25.32 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1162.68 kN.
-. phiVcz = phi * Vcz = 1046.41 kN.

-. Vuy = 232.47 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1119.41 kN.
-. phiVcy = phi * Vcy = 1007.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2080.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5985.81 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2080.20 kN.
-. phiVsz = phi*Vsz = 1872.18 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2053.72 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6029.08 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2053.72 kN.
-. phiVsy = phi*Vsy = 1848.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 233.843 kN.
-. Vr = 2855.810 kN.
-. Ratio = Vu / Vr = 0.082 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 259.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 259.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113013,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                           -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            959.68       659.02       662.15      2155.42      2047.32
           ---------------------------------------------------------------------------
            DL+LL+Others      959.68       659.02       662.15      2155.42      2047.32
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      659.02 kN-m.
           -. End Moments (My2) =      662.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      659.02 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      659.02 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2047.32 kN-m.
          -. End Moments (Mz2) =     2155.42 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2155.42 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2155.42 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2193.216 kN.
          -. Mry        =      1501.299 kN-m.
          -. Mrz        =      4915.511 kN-m.
          -. Mr         =      5139.664 kN-m.
          -. Pu/Pr      =   0.438  --->  O.K !
          -. Muy/Mry    =   0.439  --->  O.K !
          -. Muz/Mrz    =   0.438  --->  O.K !
          -. Mu/Mr      =   0.439  --->  O.K !
          -. Ratio      =   0.439  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2805.12 kN.
          -. Vuz    =         25.17 kN.
          -. Muy    =       -665.97 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.61

          -. Vuy    =        231.94 kN.
          -. Muz    =      -2147.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51
```

( ). Compute shear strength of concrete.
-. Vuz = 25.17 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1177.08 kN.
-. phiVcz = phi * Vcz = 1059.37 kN.

-. Vuy = 231.94 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1133.88 kN.
-. phiVcy = phi * Vcy = 1020.49 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2088.69 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5971.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2088.69 kN.
-. phiVsz = phi*Vsz = 1879.82 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2062.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6014.61 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2062.74 kN.
-. phiVsy = phi*Vsy = 1856.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 233.297 kN.
-. Vr = 2876.960 kN.
-. Ratio = Vu / Vr = 0.081 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 259.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 259.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113014,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            971.65       662.15       657.65      2047.32      1934.32
           ------------------------------------------------------------------------------
            DL+LL+Others      971.65       662.15       657.65      2047.32      1934.32
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      657.65 kN-m.
           -. End Moments (My2) =      662.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      662.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      662.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1934.32 kN-m.
          -. End Moments (Mz2) =     2047.32 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2047.32 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2047.32 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2309.801 kN.
          -. Mry        =      1583.266 kN-m.
          -. Mrz        =      4895.513 kN-m.
          -. Mr         =      5145.170 kN-m.
          -. Pu/Pr      =   0.421  --->  O.K !
          -. Muy/Mry    =   0.418  --->  O.K !
          -. Muz/Mrz    =   0.418  --->  O.K !
          -. Mu/Mr      =   0.421  --->  O.K !
          -. Ratio      =   0.421  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2821.80 kN.
          -. Vuz    =         28.09 kN.
          -. Muy    =       -668.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =        256.68 kN.
          -. Muz    =      -2041.83 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53
```

( ). Compute shear strength of concrete.
-. Vuz = 28.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1187.56 kN.
-. phiVcz = phi * Vcz = 1068.80 kN.

-. Vuy = 256.68 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1144.41 kN.
-. phiVcy = phi * Vcy = 1029.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2094.76 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5960.93 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2094.76 kN.
-. phiVsz = phi*Vsz = 1885.28 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2069.21 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6004.07 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2069.21 kN.
-. phiVsy = phi*Vsy = 1862.29 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 258.211 kN.
-. Vr = 2892.263 kN.
-. Ratio = Vu / Vr = 0.089 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 286.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 286.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113015,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2838.47      -664.18      -643.34     -1931.49     -1793.76
           ---------------------------------------------------------------------------
            DL+LL+Others     2838.47      -664.18      -643.34     -1931.49     -1793.76
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      643.34 kN-m.
           -. End Moments (My2) =      664.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -664.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -664.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1793.76 kN-m.
          -. End Moments (Mz2) =     1931.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1931.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1931.49 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7081.462 kN.
          -. Mry        =      1661.124 kN-m.
          -. Mrz        =      4858.677 kN-m.
          -. Mr         =      5134.791 kN-m.
          -. Pu/Pr      =   0.401  --->  O.K !
          -. Muy/Mry    =   0.400  --->  O.K !
          -. Muz/Mrz    =   0.398  --->  O.K !
          -. Mu/Mr      =   0.401  --->  O.K !
          -. Ratio      =   0.401  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2838.47 kN.
          -. Vuz    =         47.09 kN.
          -. Muy    =       -664.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.65

          -. Vuy    =        302.67 kN.
          -. Muz    =      -1931.49 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.55
```

( ). Compute shear strength of concrete.
-. Vuz = 47.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1196.20 kN.
-. phiVcz = phi * Vcz = 1076.58 kN.

-. Vuy = 302.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1153.11 kN.
-. phiVcy = phi * Vcy = 1037.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2099.71 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5952.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2099.71 kN.
-. phiVsz = phi*Vsz = 1889.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2074.48 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5995.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2074.48 kN.
-. phiVsy = phi*Vsy = 1867.03 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 306.307 kN.
-. Vr = 2904.833 kN.
-. Ratio = Vu / Vr = 0.105 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 340.34 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 340.34 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113016,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2855.14      -643.34      -609.59     -1793.76     -1636.57
           ------------------------------------------------------------------------------
            DL+LL+Others     2855.14      -643.34      -609.59     -1793.76     -1636.57
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      609.59 kN-m.
           -. End Moments (My2) =      643.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -643.34 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -643.34 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1636.57 kN-m.
          -. End Moments (Mz2) =     1793.76 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1793.76 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1793.76 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7620.464 kN.
          -. Mry        =      1718.142 kN-m.
          -. Mrz        =      4783.860 kN-m.
          -. Mr         =      5083.044 kN-m.
          -. Pu/Pr      =   0.375  --->  O.K !
          -. Muy/Mry    =   0.374  --->  O.K !
          -. Muz/Mrz    =   0.375  --->  O.K !
          -. Mu/Mr      =   0.375  --->  O.K !
          -. Ratio      =   0.375  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2855.14 kN.
          -. Vuz    =         69.46 kN.
          -. Muy    =       -643.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.68

          -. Vuy    =        333.52 kN.
          -. Muz    =      -1793.76 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.99 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.59
```

( ). Compute shear strength of concrete.
-. Vuz = 69.46 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1211.57 kN.
-. phiVcz = phi * Vcz = 1090.41 kN.

-. Vuy = 333.52 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1168.59 kN.
-. phiVcy = phi * Vcy = 1051.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2108.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5936.92 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2108.37 kN.
-. phiVsz = phi*Vsz = 1897.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2083.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5979.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2083.71 kN.
-. phiVsy = phi*Vsy = 1875.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 340.675 kN.
-. Vr = 2927.072 kN.
-. Ratio = Vu / Vr = 0.116 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 378.53 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 378.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113017,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2871.81      -609.59      -566.17     -1636.57     -1467.87
           ------------------------------------------------------------------------------
            DL+LL+Others     2871.81      -609.59      -566.17     -1636.57     -1467.87
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      566.17 kN-m.
           -. End Moments (My2) =      609.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -609.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -609.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1467.87 kN-m.
          -. End Moments (Mz2) =     1636.57 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1636.57 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1636.57 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8269.163 kN.
          -. Mry        =      1753.111 kN-m.
          -. Mrz        =      4694.510 kN-m.
          -. Mr         =      5011.170 kN-m.
          -. Pu/Pr      =   0.347  --->  O.K !
          -. Muy/Mry    =   0.348  --->  O.K !
          -. Muz/Mrz    =   0.349  --->  O.K !
          -. Mu/Mr      =   0.349  --->  O.K !
          -. Ratio      =   0.349  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2871.81 kN.
          -. Vuz    =         87.39 kN.
          -. Muy    =       -609.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.54 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73

          -. Vuy    =        349.60 kN.
          -. Muz    =      -1636.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.63
```

( ). Compute shear strength of concrete.
-. Vuz = 87.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1232.97 kN.
-. phiVcz = phi * Vcz = 1109.67 kN.

-. Vuy = 349.60 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1190.18 kN.
-. phiVcy = phi * Vcy = 1071.16 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2120.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5915.52 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2120.15 kN.
-. phiVsz = phi*Vsz = 1908.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2096.27 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5958.31 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2096.27 kN.
-. phiVsy = phi*Vsy = 1886.64 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 360.354 kN.
-. Vr = 2957.798 kN.
-. Ratio = Vu / Vr = 0.122 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 400.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 400.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113018,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2888.48      -566.17      -516.18     -1467.87     -1295.03
           ---------------------------------------------------------------------------
            DL+LL+Others     2888.48      -566.17      -516.18     -1467.87     -1295.03
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      516.18 kN-m.
           -. End Moments (My2) =      566.17 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -566.17 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -566.17 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1295.03 kN-m.
          -. End Moments (Mz2) =     1467.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1467.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1467.87 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9036.581 kN.
          -. Mry        =      1773.634 kN-m.
          -. Mrz        =      4582.465 kN-m.
          -. Mr         =      4913.733 kN-m.
          -. Pu/Pr      =   0.320  --->  O.K !
          -. Muy/Mry    =   0.319  --->  O.K !
          -. Muz/Mrz    =   0.320  --->  O.K !
          -. Mu/Mr      =   0.320  --->  O.K !
          -. Ratio      =   0.320  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2888.48 kN.
          -. Vuz    =        100.30 kN.
          -. Muy    =       -566.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.79

          -. Vuy    =        351.93 kN.
          -. Muz    =      -1467.87 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.65 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69
```

( ). Compute shear strength of concrete.
-. Vuz = 100.30 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1259.51 kN.
-. phiVcz = phi * Vcz = 1133.56 kN.

-. Vuy = 351.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1217.00 kN.
-. phiVcy = phi * Vcy = 1095.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2134.34 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5888.98 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2134.34 kN.
-. phiVsz = phi*Vsz = 1920.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2111.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5931.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2111.39 kN.
-. phiVsy = phi*Vsy = 1900.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 365.941 kN.
-. Vr = 2995.549 kN.
-. Ratio = Vu / Vr = 0.122 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 406.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 406.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113019,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2905.15      -516.18      -462.53     -1295.03     -1124.70
           ------------------------------------------------------------------------------
            DL+LL+Others     2905.15      -516.18      -462.53     -1295.03     -1124.70
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      462.53 kN-m.
           -. End Moments (My2) =      516.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -516.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -516.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1124.70 kN-m.
          -. End Moments (Mz2) =     1295.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1295.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1295.03 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9993.052 kN.
          -. Mry        =      1795.551 kN-m.
          -. Mrz        =      4487.884 kN-m.
          -. Mr         =      4833.747 kN-m.
          -. Pu/Pr      =   0.291  --->  O.K !
          -. Muy/Mry    =   0.287  --->  O.K !
          -. Muz/Mrz    =   0.289  --->  O.K !
          -. Mu/Mr      =   0.291  --->  O.K !
          -. Ratio      =   0.291  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2905.15 kN.
          -. Vuz    =        107.49 kN.
          -. Muy    =       -516.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.18 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        342.48 kN.
          -. Muz    =      -1295.03 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 107.49 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1290.20 kN.
-. phiVcz = phi * Vcz = 1161.18 kN.

-. Vuy = 342.48 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1248.07 kN.
-. phiVcy = phi * Vcy = 1123.26 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2150.16 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5858.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2150.16 kN.
-. phiVsz = phi*Vsz = 1935.15 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2128.28 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5900.42 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2128.28 kN.
-. phiVsy = phi*Vsy = 1915.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 358.950 kN.
-. Vr = 3038.715 kN.
-. Ratio = Vu / Vr = 0.118 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 398.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 398.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113020,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2921.82      -462.53      -407.87     -1124.70      -962.67
           ------------------------------------------------------------------------------
            DL+LL+Others     2921.82      -462.53      -407.87     -1124.70      -962.67
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      407.87 kN-m.
           -. End Moments (My2) =      462.53 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -462.53 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -462.53 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      962.67 kN-m.
          -. End Moments (Mz2) =     1124.70 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1124.70 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1124.70 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11314.584 kN.
          -. Mry        =      1786.648 kN-m.
          -. Mrz        =      4357.667 kN-m.
          -. Mr         =      4709.710 kN-m.
          -. Pu/Pr      =   0.258  --->  O.K !
          -. Muy/Mry    =   0.259  --->  O.K !
          -. Muz/Mrz    =   0.258  --->  O.K !
          -. Mu/Mr      =   0.259  --->  O.K !
          -. Ratio      =   0.259  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2921.82 kN.
          -. Vuz    =        109.45 kN.
          -. Muy    =       -462.53 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.93

          -. Vuy    =        324.62 kN.
          -. Muz    =      -1124.70 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 109.45 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1323.71 kN.
-. phiVcz = phi * Vcz = 1191.34 kN.

-. Vuy = 324.62 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1282.08 kN.
-. phiVcy = phi * Vcy = 1153.88 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2166.79 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5824.78 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2166.79 kN.
-. phiVsz = phi*Vsz = 1950.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2146.04 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5866.40 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2146.04 kN.
-. phiVsy = phi*Vsy = 1931.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 342.569 kN.
-. Vr = 3085.310 kN.
-. Ratio = Vu / Vr = 0.111 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 380.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 380.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113021,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2938.48      -407.87      -354.40      -962.67      -812.66
           ------------------------------------------------------------------------------
            DL+LL+Others     2938.48      -407.87      -354.40      -962.67      -812.66
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      354.40 kN-m.
           -. End Moments (My2) =      407.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -407.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -407.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      812.66 kN-m.
          -. End Moments (Mz2) =      962.67 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -962.67 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -962.67 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12779.142 kN.
          -. Mry        =      1775.579 kN-m.
          -. Mrz        =      4202.818 kN-m.
          -. Mr         =      4562.495 kN-m.
          -. Pu/Pr      =   0.230  --->  O.K !
          -. Muy/Mry    =   0.230  --->  O.K !
          -. Muz/Mrz    =   0.229  --->  O.K !
          -. Mu/Mr      =   0.230  --->  O.K !
          -. Ratio      =   0.230  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2938.48 kN.
          -. Vuz    =        107.00 kN.
          -. Muy    =       -407.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =        300.45 kN.
          -. Muz    =       -962.67 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 107.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1358.78 kN.
-. phiVcz = phi * Vcz = 1222.90 kN.

-. Vuy = 300.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1317.77 kN.
-. phiVcy = phi * Vcy = 1186.00 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2183.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5789.71 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2183.49 kN.
-. phiVsz = phi*Vsz = 1965.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2163.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5830.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2163.89 kN.
-. phiVsy = phi*Vsy = 1947.50 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 318.937 kN.
-. Vr = 3133.500 kN.
-. Ratio = Vu / Vr = 0.102 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 354.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 354.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113022,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2955.15      -354.40      -303.31      -812.66      -674.92
           ------------------------------------------------------------------------------
            DL+LL+Others     2955.15      -354.40      -303.31      -812.66      -674.92
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      303.31 kN-m.
           -. End Moments (My2) =      354.40 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -354.40 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -354.40 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      674.92 kN-m.
          -. End Moments (Mz2) =      812.66 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -812.66 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -812.66 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14528.457 kN.
          -. Mry        =      1738.154 kN-m.
          -. Mrz        =      3990.260 kN-m.
          -. Mr         =      4352.396 kN-m.
          -. Pu/Pr      =   0.203  --->  O.K !
          -. Muy/Mry    =   0.204  --->  O.K !
          -. Muz/Mrz    =   0.204  --->  O.K !
          -. Mu/Mr      =   0.204  --->  O.K !
          -. Ratio      =   0.204  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2955.15 kN.
          -. Vuz    =        102.26 kN.
          -. Muy    =       -354.40 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.08

          -. Vuy    =        275.92 kN.
          -. Muz    =       -812.66 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.00
```

( ). Compute shear strength of concrete.
-. Vuz = 102.26 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1393.54 kN.
-. phiVcz = phi * Vcz = 1254.19 kN.

-. Vuy = 275.92 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1353.24 kN.
-. phiVcy = phi * Vcy = 1217.92 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2199.39 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5754.94 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2199.39 kN.
-. phiVsz = phi*Vsz = 1979.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2180.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5795.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2180.90 kN.
-. phiVsy = phi*Vsy = 1962.81 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 294.258 kN.
-. Vr = 3180.726 kN.
-. Ratio = Vu / Vr = 0.093 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 326.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 326.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113023,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2971.82      -303.31      -255.62      -674.92      -551.14
           ------------------------------------------------------------------------------
            DL+LL+Others     2971.82      -303.31      -255.62      -674.92      -551.14
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      255.62 kN-m.
           -. End Moments (My2) =      303.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -303.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -303.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      551.14 kN-m.
          -. End Moments (Mz2) =      674.92 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -674.92 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -674.92 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     16493.017 kN.
          -. Mry        =      1667.176 kN-m.
          -. Mrz        =      3712.714 kN-m.
          -. Mr         =      4069.855 kN-m.
          -. Pu/Pr      =   0.180  --->  O.K !
          -. Muy/Mry    =   0.182  --->  O.K !
          -. Muz/Mrz    =   0.182  --->  O.K !
          -. Mu/Mr      =   0.182  --->  O.K !
          -. Ratio      =   0.182  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2971.82 kN.
          -. Vuz    =         95.41 kN.
          -. Muy    =       -303.31 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.42 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.16

          -. Vuy    =        248.06 kN.
          -. Muz    =       -674.92 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.07
```

( ). Compute shear strength of concrete.
-. Vuz = 95.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1428.18 kN.
-. phiVcz = phi * Vcz = 1285.36 kN.

-. Vuy = 248.06 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1388.67 kN.
-. phiVcy = phi * Vcy = 1249.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2214.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5720.31 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2214.62 kN.
-. phiVsz = phi*Vsz = 1993.15 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2197.20 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5759.82 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2197.20 kN.
-. phiVsy = phi*Vsy = 1977.48 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 265.781 kN.
-. Vr = 3227.283 kN.
-. Ratio = Vu / Vr = 0.082 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 295.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 295.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113024,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2988.48      -255.62      -212.11      -551.14      -442.49
           ---------------------------------------------------------------------------
            DL+LL+Others     2988.48      -255.62      -212.11      -551.14      -442.49
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      212.11 kN-m.
           -. End Moments (My2) =      255.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -255.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -255.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      442.49 kN-m.
          -. End Moments (Mz2) =      551.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -551.14 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -551.14 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     18345.409 kN.
          -. Mry        =      1576.085 kN-m.
          -. Mrz        =      3399.418 kN-m.
          -. Mr         =      3747.010 kN-m.
          -. Pu/Pr      =   0.163  --->  O.K !
          -. Muy/Mry    =   0.162  --->  O.K !
          -. Muz/Mrz    =   0.162  --->  O.K !
          -. Mu/Mr      =   0.163  --->  O.K !
          -. Ratio      =   0.163  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2988.48 kN.
          -. Vuz    =         87.07 kN.
          -. Muy    =       -255.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.24

          -. Vuy    =        218.27 kN.
          -. Muz    =       -551.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.15
```

( ). Compute shear strength of concrete.
-. Vuz = 87.07 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1461.80 kN.
-. phiVcz = phi * Vcz = 1315.62 kN.

-. Vuy = 218.27 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1423.15 kN.
-. phiVcy = phi * Vcy = 1280.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2228.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5686.69 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2228.84 kN.
-. phiVsz = phi*Vsz = 2005.96 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2212.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5725.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2212.44 kN.
-. phiVsy = phi*Vsy = 1991.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 234.998 kN.
-. Vr = 3272.030 kN.
-. Ratio = Vu / Vr = 0.072 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 261.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 261.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113025,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3005.15      -212.11      -173.24      -442.49      -349.07
           ------------------------------------------------------------------------------
            DL+LL+Others     3005.15      -212.11      -173.24      -442.49      -349.07
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      173.24 kN-m.
           -. End Moments (My2) =      212.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -212.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -212.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      349.07 kN-m.
          -. End Moments (Mz2) =      442.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -442.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -442.49 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     20380.027 kN.
          -. Mry        =      1436.895 kN-m.
          -. Mrz        =      2995.362 kN-m.
          -. Mr         =      3322.177 kN-m.
          -. Pu/Pr      =   0.147  --->  O.K !
          -. Muy/Mry    =   0.148  --->  O.K !
          -. Muz/Mrz    =   0.148  --->  O.K !
          -. Mu/Mr      =   0.148  --->  O.K !
          -. Ratio      =   0.148  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3005.15 kN.
          -. Vuz    =         77.76 kN.
          -. Muy    =       -212.11 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.11 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.31

          -. Vuy    =        187.73 kN.
          -. Muz    =       -442.49 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.28 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.22
```

( ). Compute shear strength of concrete.
-. Vuz = 77.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1493.56 kN.
-. phiVcz = phi * Vcz = 1344.20 kN.

-. Vuy = 187.73 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1455.80 kN.
-. phiVcy = phi * Vcy = 1310.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2241.81 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5654.93 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2241.81 kN.
-. phiVsz = phi*Vsz = 2017.63 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2226.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5692.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2226.34 kN.
-. phiVsy = phi*Vsy = 2003.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 203.199 kN.
-. Vr = 3313.922 kN.
-. Ratio = Vu / Vr = 0.061 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 225.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 225.78 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113026,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3610.55       -62.49       -50.05       -57.59       -47.64
           ------------------------------------------------------------------------------
            DL+LL+Others     3610.55       -62.49       -50.05       -57.59       -47.64
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       50.05 kN-m.
           -. End Moments (My2) =       62.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -50.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -50.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       47.64 kN-m.
          -. End Moments (Mz2) =       57.59 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -47.64 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -47.64 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       338.309 kN-m.
          -. Mrz        =       321.965 kN-m.
          -. Mr         =       467.027 kN-m.
          -. Pu/Pr      =   0.148  --->  O.K !
          -. Muy/Mry    =   0.148  --->  O.K !
          -. Muz/Mrz    =   0.148  --->  O.K !
          -. Mu/Mr      =   0.148  --->  O.K !
          -. Ratio      =   0.148  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3021.81 kN.
          -. Vuz    =         67.95 kN.
          -. Muy    =       -173.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.37

          -. Vuy    =        157.44 kN.
          -. Muz    =       -349.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.29
```

( ). Compute shear strength of concrete.
-. Vuz = 67.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1522.80 kN.
-. phiVcz = phi * Vcz = 1370.52 kN.

-. Vuy = 157.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1485.93 kN.
-. phiVcy = phi * Vcy = 1337.34 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2253.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5625.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2253.36 kN.
-. phiVsz = phi*Vsz = 2028.02 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2238.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5662.56 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2238.73 kN.
-. phiVsy = phi*Vsy = 2014.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 171.481 kN.
-. Vr = 3352.197 kN.
-. Ratio = Vu / Vr = 0.051 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 190.53 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 190.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113027,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3627.21       -50.05       -39.26       -47.64       -38.61
           ------------------------------------------------------------------------------
            DL+LL+Others     3627.21       -50.05       -39.26       -47.64       -38.61
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       39.26 kN-m.
           -. End Moments (My2) =       50.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -39.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -39.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       38.61 kN-m.
          -. End Moments (Mz2) =       47.64 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -38.61 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -38.61 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       264.198 kN-m.
          -. Mrz        =       259.739 kN-m.
          -. Mr         =       370.493 kN-m.
          -. Pu/Pr      =   0.149  --->  O.K !
          -. Muy/Mry    =   0.149  --->  O.K !
          -. Muz/Mrz    =   0.149  --->  O.K !
          -. Mu/Mr      =   0.149  --->  O.K !
          -. Ratio      =   0.149  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3038.47 kN.
          -. Vuz    =         59.20 kN.
          -. Muy    =       -139.28 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.43

          -. Vuy    =        131.71 kN.
          -. Muz    =       -270.65 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.35
```

( ). Compute shear strength of concrete.
-. Vuz = 59.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1548.19 kN.
-. phiVcz = phi * Vcz = 1393.37 kN.

-. Vuy = 131.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1512.14 kN.
-. phiVcy = phi * Vcy = 1360.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2263.10 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5600.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2263.10 kN.
-. phiVsz = phi*Vsz = 2036.79 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2249.19 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5636.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2249.19 kN.
-. phiVsy = phi*Vsy = 2024.27 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 144.400 kN.
-. Vr = 3385.202 kN.
-. Ratio = Vu / Vr = 0.043 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 160.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 160.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113028,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3643.86       -39.26       -29.63       -38.61       -30.30
           ------------------------------------------------------------------------------
            DL+LL+Others     3643.86       -39.26       -29.63       -38.61       -30.30
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       29.63 kN-m.
           -. End Moments (My2) =       39.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -29.63 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -29.63 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       30.30 kN-m.
          -. End Moments (Mz2) =       38.61 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -30.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -30.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       198.424 kN-m.
          -. Mrz        =       202.943 kN-m.
          -. Mr         =       283.827 kN-m.
          -. Pu/Pr      =   0.149  --->  O.K !
          -. Muy/Mry    =   0.149  --->  O.K !
          -. Muz/Mrz    =   0.149  --->  O.K !
          -. Mu/Mr      =   0.149  --->  O.K !
          -. Ratio      =   0.149  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3055.14 kN.
          -. Vuz    =         53.01 kN.
          -. Muy    =       -109.69 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.47

          -. Vuy    =        114.25 kN.
          -. Muz    =       -204.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.39
```

( ). Compute shear strength of concrete.
-. Vuz = 53.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1568.97 kN.
-. phiVcz = phi * Vcz = 1412.08 kN.

-. Vuy = 114.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1533.64 kN.
-. phiVcy = phi * Vcy = 1380.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2270.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5579.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2270.89 kN.
-. phiVsz = phi*Vsz = 2043.80 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2257.55 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5614.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2257.55 kN.
-. phiVsy = phi*Vsy = 2031.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 125.944 kN.
-. Vr = 3412.070 kN.
-. Ratio = Vu / Vr = 0.037 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 139.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 139.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113029,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3660.52       -29.63       -21.08       -30.30       -23.02
           ------------------------------------------------------------------------------
            DL+LL+Others     3660.52       -29.63       -21.08       -30.30       -23.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       21.08 kN-m.
           -. End Moments (My2) =       29.63 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -21.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -21.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       23.02 kN-m.
          -. End Moments (Mz2) =       30.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -23.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -23.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       140.381 kN-m.
          -. Mrz        =       153.615 kN-m.
          -. Mr         =       208.097 kN-m.
          -. Pu/Pr      =   0.150  --->  O.K !
          -. Muy/Mry    =   0.150  --->  O.K !
          -. Muz/Mrz    =   0.150  --->  O.K !
          -. Mu/Mr      =   0.150  --->  O.K !
          -. Ratio      =   0.150  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3071.80 kN.
          -. Vuz    =         47.25 kN.
          -. Muy    =        -83.20 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.51

          -. Vuy    =         98.63 kN.
          -. Muz    =       -148.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.44
```

( ). Compute shear strength of concrete.
-. Vuz = 47.25 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1587.43 kN.
-. phiVcz = phi * Vcz = 1428.68 kN.

-. Vuy = 98.63 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1552.75 kN.
-. phiVcy = phi * Vcy = 1397.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2277.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5561.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2277.66 kN.
-. phiVsz = phi*Vsz = 2049.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2264.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5595.74 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2264.83 kN.
-. phiVsy = phi*Vsy = 2038.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 109.358 kN.
-. Vr = 3435.818 kN.
-. Ratio = Vu / Vr = 0.032 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 121.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 121.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113030,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3677.18       -21.08       -13.50       -23.02       -16.30
           ------------------------------------------------------------------------------
            DL+LL+Others     3677.18       -21.08       -13.50       -23.02       -16.30
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.50 kN-m.
           -. End Moments (My2) =       21.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.50 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.50 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       16.30 kN-m.
          -. End Moments (Mz2) =       23.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -16.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -16.30 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        89.629 kN-m.
          -. Mrz        =       108.171 kN-m.
          -. Mr         =       140.479 kN-m.
          -. Pu/Pr      =   0.151  --->  O.K !
          -. Muy/Mry    =   0.151  --->  O.K !
          -. Muz/Mrz    =   0.151  --->  O.K !
          -. Mu/Mr      =   0.151  --->  O.K !
          -. Ratio      =   0.151  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3088.46 kN.
          -. Vuz    =         42.04 kN.
          -. Muy    =        -59.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.55

          -. Vuy    =         85.04 kN.
          -. Muz    =        -98.88 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.47
```

( ). Compute shear strength of concrete.
-. Vuz = 42.04 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1603.54 kN.
-. phiVcz = phi * Vcz = 1443.19 kN.

-. Vuy = 85.04 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1569.46 kN.
-. phiVcy = phi * Vcy = 1412.52 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2283.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5544.95 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2283.47 kN.
-. phiVsz = phi*Vsz = 2055.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2271.07 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5579.02 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2271.07 kN.
-. phiVsy = phi*Vsy = 2043.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 94.861 kN.
-. Vr = 3456.480 kN.
-. Ratio = Vu / Vr = 0.027 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 105.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 105.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113031,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3693.83       -13.50        -7.57       -16.30       -10.61
           ------------------------------------------------------------------------------
            DL+LL+Others     3693.83       -13.50        -7.57       -16.30       -10.61
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.57 kN-m.
           -. End Moments (My2) =       13.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       10.61 kN-m.
          -. End Moments (Mz2) =       16.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -10.61 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -10.61 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        50.017 kN-m.
          -. Mrz        =        70.074 kN-m.
          -. Mr         =        86.093 kN-m.
          -. Pu/Pr      =   0.151  --->  O.K !
          -. Muy/Mry    =   0.151  --->  O.K !
          -. Muz/Mrz    =   0.151  --->  O.K !
          -. Mu/Mr      =   0.151  --->  O.K !
          -. Ratio      =   0.151  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3105.12 kN.
          -. Vuz    =         33.17 kN.
          -. Muy    =        -38.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.59

          -. Vuy    =         62.80 kN.
          -. Muz    =        -56.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.71 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.51
```

( ). Compute shear strength of concrete.
-. Vuz = 33.17 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1620.15 kN.
-. phiVcz = phi * Vcz = 1458.14 kN.

-. Vuy = 62.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1586.71 kN.
-. phiVcy = phi * Vcy = 1428.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2289.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5528.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2289.37 kN.
-. phiVsz = phi*Vsz = 2060.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2277.40 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5561.77 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2277.40 kN.
-. phiVsy = phi*Vsy = 2049.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 71.021 kN.
-. Vr = 3477.704 kN.
-. Ratio = Vu / Vr = 0.020 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 78.91 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 78.91 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113032,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3710.49        -7.57        -3.66       -10.61        -6.49
           ------------------------------------------------------------------------------
            DL+LL+Others     3710.49        -7.57        -3.66       -10.61        -6.49
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.66 kN-m.
           -. End Moments (My2) =        7.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.66 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.66 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        6.49 kN-m.
          -. End Moments (Mz2) =       10.61 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -6.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -6.49 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        24.078 kN-m.
          -. Mrz        =        42.686 kN-m.
          -. Mr         =        49.009 kN-m.
          -. Pu/Pr      =   0.152  --->  O.K !
          -. Muy/Mry    =   0.152  --->  O.K !
          -. Muz/Mrz    =   0.152  --->  O.K !
          -. Mu/Mr      =   0.152  --->  O.K !
          -. Ratio      =   0.152  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3122.42 kN.
          -. Vuz    =         38.87 kN.
          -. Muy    =        -17.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.62

          -. Vuy    =         18.21 kN.
          -. Muz    =         -7.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.54
```

```
( ). Compute shear strength of concrete.
     -. Vuz       =       38.87 kN.
     -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1633.71 kN.
     -. phiVcz    = phi * Vcz =     1470.34 kN.

     -. Vuy       =       18.21 kN.
     -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1600.81 kN.
     -. phiVcy    = phi * Vcy =     1440.73 kN.

( ). Compute maximum spacing of ties.
     -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
     -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
     -. Applied spacing s_z   =    0.150 m.

     -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
     -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
     -. Applied spacing s_y   =    0.150 m.

     -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

( ). Compute shear strength of reinforcement.
     -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2294.10 kN.
     -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5514.78 kN.
     -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2294.10 kN.
     -. phiVsz   = phi*Vsz =     2064.69 kN.
     -. phiVsz > (Vuz-phiVcz)  --->  O.K !
     -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

     -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2282.50 kN.
     -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5547.68 kN.
     -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2282.50 kN.
     -. phiVsy   = phi*Vsy =     2054.25 kN.
     -. phiVsy > (Vuy-phiVcy)  --->  O.K !
     -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

     -. Vu       =      42.924 kN.
     -. Vr       =    3494.974 kN.
     -. Ratio    = Vu / Vr = 0.012  --->  O.K !

( ). Compute minimum longitudinal reinforcement by shear.
     -. phia     =   0.75
     -. phib     =   0.90
     -. phiv     =   0.90
     -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =       47.69 kN.
     -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =       47.69 kN.
     -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy =  -
0.0049 m^2.
     -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy =  -
0.0049 m^2.
     -. As_req  =  MAX[ Asy_req, Asz_req ] =  -0.0049 m^2.
     -. As      =   0.0363 m^2.
     -. As_req < As  --->  O.K !
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113033,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3727.14        -3.66        -1.39        -6.49        -3.82
           ------------------------------------------------------------------------------
            DL+LL+Others     3727.14        -3.66        -1.39        -6.49        -3.82
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.39 kN-m.
           -. End Moments (My2) =        3.66 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.82 kN-m.
          -. End Moments (Mz2) =        6.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.82 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         9.068 kN-m.
          -. Mrz        =        25.000 kN-m.
          -. Mr         =        26.594 kN-m.
          -. Pu/Pr      =   0.153  --->  O.K !
          -. Muy/Mry    =   0.153  --->  O.K !
          -. Muz/Mrz    =   0.153  --->  O.K !
          -. Mu/Mr      =   0.153  --->  O.K !
          -. Ratio      =   0.153  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3139.08 kN.
          -. Vuz    =         22.47 kN.
          -. Muy    =         -6.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.63

          -. Vuy    =          9.28 kN.
          -. Muz    =         -4.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.63 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.56
```

( ). Compute shear strength of concrete.
-. Vuz = 22.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1640.81 kN.
-. phiVcz = phi * Vcz = 1476.73 kN.

-. Vuy = 9.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1608.20 kN.
-. phiVcy = phi * Vcy = 1447.38 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2296.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5507.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2296.56 kN.
-. phiVsz = phi*Vsz = 2066.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2285.13 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5540.29 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2285.13 kN.
-. phiVsy = phi*Vsy = 2056.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 24.312 kN.
-. Vr = 3503.998 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 27.01 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 27.01 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113034,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3743.80        -1.39        -0.38        -3.82        -1.88
           ------------------------------------------------------------------------------
            DL+LL+Others     3743.80        -1.39        -0.38        -3.82        -1.88
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.38 kN-m.
           -. End Moments (My2) =        1.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.88 kN-m.
          -. End Moments (Mz2) =        3.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.88 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         2.478 kN-m.
          -. Mrz        =        12.231 kN-m.
          -. Mr         =        12.479 kN-m.
          -. Pu/Pr      =   0.153  --->  O.K !
          -. Muy/Mry    =   0.153  --->  O.K !
          -. Muz/Mrz    =   0.153  --->  O.K !
          -. Mu/Mr      =   0.153  --->  O.K !
          -. Ratio      =   0.153  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3155.74 kN.
          -. Vuz    =         10.43 kN.
          -. Muy    =         -1.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =          4.36 kN.
          -. Muz    =         -2.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 10.43 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1645.19 kN.
-. phiVcz = phi * Vcz = 1480.67 kN.

-. Vuy = 4.36 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1612.75 kN.
-. phiVcy = phi * Vcy = 1451.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2298.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5503.30 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2298.06 kN.
-. phiVsz = phi*Vsz = 2068.25 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.75 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5535.74 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.75 kN.
-. phiVsy = phi*Vsy = 2058.08 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 11.307 kN.
-. Vr = 3509.551 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 12.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 12.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0051 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0051 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0051 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113035,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3760.45        -0.38        -0.15        -1.88        -0.53
           ------------------------------------------------------------------------------
            DL+LL+Others     3760.45        -0.38        -0.15        -1.88        -0.53
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.15 kN-m.
           -. End Moments (My2) =        0.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.53 kN-m.
          -. End Moments (Mz2) =        1.88 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.53 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.53 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.975 kN-m.
          -. Mrz        =         3.458 kN-m.
          -. Mr         =         3.592 kN-m.
          -. Pu/Pr      =   0.154  --->  O.K !
          -. Muy/Mry    =   0.154  --->  O.K !
          -. Muz/Mrz    =   0.154  --->  O.K !
          -. Mu/Mr      =   0.154  --->  O.K !
          -. Ratio      =   0.154  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3188.41 kN.
          -. Vuz    =          2.20 kN.
          -. Muy    =         -0.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =          6.57 kN.
          -. Muz    =         -2.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 2.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1643.31 kN.
-. phiVcz = phi * Vcz = 1478.98 kN.

-. Vuy = 6.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1610.79 kN.
-. phiVcy = phi * Vcy = 1449.71 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2297.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5505.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2297.42 kN.
-. phiVsz = phi*Vsz = 2067.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.06 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5537.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.06 kN.
-. phiVsy = phi*Vsy = 2057.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 6.930 kN.
-. Vr = 3507.166 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 7.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 7.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0051 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0051 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0051 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113036,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3777.11        -0.15         0.00        -0.53         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3777.11        -0.15         0.00        -0.53         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y             =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.53 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z             =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.155  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.155  --->  O.K !
          -. Ratio      =   0.155  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3205.07 kN.
          -. Vuz    =          0.44 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.56

          -. Vuy    =          4.30 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.56
```

( ). Compute shear strength of concrete.
-. Vuz = 0.44 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1609.99 kN.
-. phiVcz = phi * Vcz = 1448.99 kN.

-. Vuy = 4.30 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1609.99 kN.
-. phiVcy = phi * Vcy = 1448.99 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2285.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5538.49 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2285.77 kN.
-. phiVsz = phi*Vsz = 2057.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2285.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5538.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2285.77 kN.
-. phiVsy = phi*Vsy = 2057.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 4.317 kN.
-. Vr = 3506.192 kN.
-. Ratio = Vu / Vr = 0.001 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 4.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 4.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114002,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1081.62       376.57       474.80      3243.67      3329.80
           ------------------------------------------------------------------------------
            DL+LL+Others     1081.62       376.57       474.80      3243.67      3329.80
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      376.57 kN-m.
           -. End Moments (My2) =      474.80 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      474.80 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      474.80 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3243.67 kN-m.
          -. End Moments (Mz2) =     3329.80 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3329.80 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3329.80 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1644.826 kN.
          -. Mry        =       725.946 kN-m.
          -. Mrz        =      5054.348 kN-m.
          -. Mr         =      5106.215 kN-m.
          -. Pu/Pr      =   0.658  --->  O.K !
          -. Muy/Mry    =   0.654  --->  O.K !
          -. Muz/Mrz    =   0.659  --->  O.K !
          -. Mu/Mr      =   0.659  --->  O.K !
          -. Ratio      =   0.659  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2324.28 kN.
          -. Vuz    =        412.77 kN.
          -. Muy    =      -1058.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =        145.93 kN.
          -. Muz    =      -1542.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 412.77 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1240.35 kN.
-. phiVcz = phi * Vcz = 1116.31 kN.

-. Vuy = 145.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1197.63 kN.
-. phiVcy = phi * Vcy = 1077.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2124.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5908.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2124.15 kN.
-. phiVsz = phi*Vsz = 1911.73 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2100.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5950.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2100.52 kN.
-. phiVsy = phi*Vsy = 1890.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 437.807 kN.
-. Vr = 2968.337 kN.
-. Ratio = Vu / Vr = 0.147 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 486.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 486.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114003,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1093.61       474.80       559.89      3329.80      3374.46
           ---------------------------------------------------------------------------
            DL+LL+Others    1093.61       474.80       559.89      3329.80      3374.46
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      474.80 kN-m.
           -. End Moments (My2) =      559.89 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      559.89 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      559.89 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3329.80 kN-m.
          -. End Moments (Mz2) =     3374.46 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3374.46 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3374.46 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1627.241 kN.
          -. Mry        =       838.058 kN-m.
          -. Mrz        =      5035.559 kN-m.
          -. Mr         =      5104.821 kN-m.
          -. Pu/Pr      =   0.672  --->  O.K !
          -. Muy/Mry    =   0.668  --->  O.K !
          -. Muz/Mrz    =   0.670  --->  O.K !
          -. Mu/Mr      =   0.672  --->  O.K !
          -. Ratio      =   0.672  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2340.95 kN.
          -. Vuz    =        351.22 kN.
          -. Muy    =      -1223.64 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73

          -. Vuy    =        111.31 kN.
          -. Muz    =      -1549.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.63
```

( ). Compute shear strength of concrete.
-. Vuz = 351.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1232.09 kN.
-. phiVcz = phi * Vcz = 1108.88 kN.

-. Vuy = 111.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1189.29 kN.
-. phiVcy = phi * Vcy = 1070.36 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2119.68 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5916.40 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2119.68 kN.
-. phiVsz = phi*Vsz = 1907.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2095.76 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5959.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2095.76 kN.
-. phiVsy = phi*Vsy = 1886.18 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 368.437 kN.
-. Vr = 2956.541 kN.
-. Ratio = Vu / Vr = 0.125 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 409.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 409.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114004,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1105.59       559.89       631.11      3374.46      3379.77
           ---------------------------------------------------------------------------
            DL+LL+Others    1105.59       559.89       631.11      3374.46      3379.77
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      559.89 kN-m.
           -. End Moments (My2) =      631.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      631.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      631.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3374.46 kN-m.
          -. End Moments (Mz2) =     3379.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3379.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3379.77 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1629.087 kN.
          -. Mry        =       937.456 kN-m.
          -. Mrz        =      5018.149 kN-m.
          -. Mr         =      5104.962 kN-m.
          -. Pu/Pr      =   0.679  --->  O.K !
          -. Muy/Mry    =   0.673  --->  O.K !
          -. Muz/Mrz    =   0.674  --->  O.K !
          -. Mu/Mr      =   0.679  --->  O.K !
          -. Ratio      =   0.679  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2357.61 kN.
          -. Vuz    =        290.99 kN.
          -. Muy    =      -1359.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.72

          -. Vuy    =         88.24 kN.
          -. Muz    =      -1539.83 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.88 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.62
```

( ). Compute shear strength of concrete.
-. Vuz = 290.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1227.06 kN.
-. phiVcz = phi * Vcz = 1104.35 kN.

-. Vuy = 88.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1184.21 kN.
-. phiVcy = phi * Vcy = 1065.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2116.93 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5921.43 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2116.93 kN.
-. phiVsz = phi*Vsz = 1905.24 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2092.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5964.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2092.83 kN.
-. phiVsy = phi*Vsy = 1883.55 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 304.073 kN.
-. Vr = 2949.339 kN.
-. Ratio = Vu / Vr = 0.103 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 337.86 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 337.86 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114005,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1105.58       631.11       688.54      3379.77      3348.29
           ---------------------------------------------------------------------------
            DL+LL+Others     1105.58       631.11       688.54      3379.77      3348.29
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      631.11 kN-m.
           -. End Moments (My2) =      688.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      631.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      631.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3348.29 kN-m.
          -. End Moments (Mz2) =     3379.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3379.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3379.77 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1629.087 kN.
          -. Mry        =       937.456 kN-m.
          -. Mrz        =      5018.149 kN-m.
          -. Mr         =      5104.962 kN-m.
          -. Pu/Pr      =   0.679  --->  O.K !
          -. Muy/Mry    =   0.673  --->  O.K !
          -. Muz/Mrz    =   0.674  --->  O.K !
          -. Mu/Mr      =   0.679  --->  O.K !
          -. Ratio      =   0.679  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2374.28 kN.
          -. Vuz    =        232.67 kN.
          -. Muy    =      -1466.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71

          -. Vuy    =         81.62 kN.
          -. Muz    =      -1514.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.62
```

( ). Compute shear strength of concrete.
-. Vuz = 232.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1225.13 kN.
-. phiVcz = phi * Vcz = 1102.62 kN.

-. Vuy = 81.62 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1182.27 kN.
-. phiVcy = phi * Vcy = 1064.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2115.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5923.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2115.88 kN.
-. phiVsz = phi*Vsz = 1904.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2091.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5966.22 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2091.71 kN.
-. phiVsy = phi*Vsy = 1882.53 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 246.572 kN.
-. Vr = 2946.576 kN.
-. Ratio = Vu / Vr = 0.084 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 273.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 273.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114006,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1117.57       688.54       733.21      3348.29      3282.93
           ---------------------------------------------------------------------------
            DL+LL+Others     1117.57       688.54       733.21      3348.29      3282.93
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      688.54 kN-m.
           -. End Moments (My2) =      733.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      688.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      688.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3282.93 kN-m.
          -. End Moments (Mz2) =     3348.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3348.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3348.29 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1674.270 kN.
          -. Mry        =      1027.354 kN-m.
          -. Mrz        =      5004.186 kN-m.
          -. Mr         =      5108.555 kN-m.
          -. Pu/Pr      =   0.667  --->  O.K !
          -. Muy/Mry    =   0.670  --->  O.K !
          -. Muz/Mrz    =   0.669  --->  O.K !
          -. Mu/Mr      =   0.670  --->  O.K !
          -. Ratio      =   0.670  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2390.94 kN.
          -. Vuz    =        176.90 kN.
          -. Muy    =      -1547.40 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71

          -. Vuy    =         88.10 kN.
          -. Muz    =      -1475.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.62
```

( ). Compute shear strength of concrete.
-. Vuz = 176.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1225.98 kN.
-. phiVcz = phi * Vcz = 1103.38 kN.

-. Vuy = 88.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1183.12 kN.
-. phiVcy = phi * Vcy = 1064.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2116.34 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5922.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2116.34 kN.
-. phiVsz = phi*Vsz = 1904.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2092.20 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5965.36 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2092.20 kN.
-. phiVsy = phi*Vsy = 1882.98 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 197.619 kN.
-. Vr = 2947.791 kN.
-. Ratio = Vu / Vr = 0.067 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 219.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 219.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114007,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1129.56       733.21       767.10      3282.93      3186.94
           ---------------------------------------------------------------------------
            DL+LL+Others    1129.56       733.21       767.10      3282.93      3186.94
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      733.21 kN-m.
           -. End Moments (My2) =      767.10 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      733.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      733.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3186.94 kN-m.
          -. End Moments (Mz2) =     3282.93 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3282.93 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3282.93 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1717.388 kN.
          -. Mry        =      1110.343 kN-m.
          -. Mrz        =      4989.929 kN-m.
          -. Mr         =      5111.971 kN-m.
          -. Pu/Pr      =   0.658  --->  O.K !
          -. Muy/Mry    =   0.660  --->  O.K !
          -. Muz/Mrz    =   0.658  --->  O.K !
          -. Mu/Mr      =   0.660  --->  O.K !
          -. Ratio      =   0.660  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2356.63 kN.
          -. Vuz    =         74.33 kN.
          -. Muy    =       -743.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35

          -. Vuy    =        194.77 kN.
          -. Muz    =      -3255.78 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.28 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.25
```

( ). Compute shear strength of concrete.
-. Vuz = 74.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1060.98 kN.
-. phiVcz = phi * Vcz = 954.88 kN.

-. Vuy = 194.77 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1017.66 kN.
-. phiVcy = phi * Vcy = 915.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2015.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6087.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2015.37 kN.
-. phiVsz = phi*Vsz = 1813.84 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1984.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6130.82 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1984.84 kN.
-. phiVsy = phi*Vsy = 1786.35 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 208.468 kN.
-. Vr = 2702.251 kN.
-. Ratio = Vu / Vr = 0.077 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 231.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 231.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0070 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0070 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0070 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114008,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1141.54       767.10       790.74      3186.94      3063.86
           ---------------------------------------------------------------------------
            DL+LL+Others    1141.54       767.10       790.74      3186.94      3063.86
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      767.10 kN-m.
           -. End Moments (My2) =      790.74 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      767.10 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      767.10 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3063.86 kN-m.
          -. End Moments (Mz2) =     3186.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3186.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3186.94 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1765.516 kN.
          -. Mry        =      1193.230 kN-m.
          -. Mrz        =      4973.284 kN-m.
          -. Mr         =      5114.426 kN-m.
          -. Pu/Pr      =   0.647  --->  O.K !
          -. Muy/Mry    =   0.643  --->  O.K !
          -. Muz/Mrz    =   0.641  --->  O.K !
          -. Mu/Mr      =   0.647  --->  O.K !
          -. Ratio      =   0.647  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2373.29 kN.
          -. Vuz    =         49.83 kN.
          -. Muy    =       -774.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.36

          -. Vuy    =        245.54 kN.
          -. Muz    =      -3163.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.26
```

( ). Compute shear strength of concrete.
-. Vuz = 49.83 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1065.66 kN.
-. phiVcz = phi * Vcz = 959.10 kN.

-. Vuy = 245.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1022.33 kN.
-. phiVcy = phi * Vcy = 920.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2018.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6082.82 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2018.56 kN.
-. phiVsz = phi*Vsz = 1816.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1988.22 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6126.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1988.22 kN.
-. phiVsy = phi*Vsy = 1789.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 250.541 kN.
-. Vr = 2709.500 kN.
-. Ratio = Vu / Vr = 0.092 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 278.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 278.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0068 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0068 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0068 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114009,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1153.53       790.74       803.04      3063.86      2917.46
           ---------------------------------------------------------------------------
            DL+LL+Others    1153.53       790.74       803.04      3063.86      2917.46
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      790.74 kN-m.
           -. End Moments (My2) =      803.04 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      790.74 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      790.74 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2917.46 kN-m.
          -. End Moments (Mz2) =     3063.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3063.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3063.86 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1869.369 kN.
          -. Mry        =      1280.011 kN-m.
          -. Mrz        =      4956.275 kN-m.
          -. Mr         =      5118.896 kN-m.
          -. Pu/Pr      =   0.617  --->  O.K !
          -. Muy/Mry    =   0.618  --->  O.K !
          -. Muz/Mrz    =   0.618  --->  O.K !
          -. Mu/Mr      =   0.618  --->  O.K !
          -. Ratio      =   0.618  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2389.96 kN.
          -. Vuz    =         27.78 kN.
          -. Muy    =       -795.83 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.38

          -. Vuy    =        290.63 kN.
          -. Muz    =      -3043.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.28
```

( ). Compute shear strength of concrete.
-. Vuz = 27.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1073.87 kN.
-. phiVcz = phi * Vcz = 966.49 kN.

-. Vuy = 290.63 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1030.52 kN.
-. phiVcy = phi * Vcy = 927.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2024.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6074.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2024.11 kN.
-. phiVsz = phi*Vsz = 1821.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1994.10 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6117.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1994.10 kN.
-. phiVsy = phi*Vsy = 1794.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 291.955 kN.
-. Vr = 2722.162 kN.
-. Ratio = Vu / Vr = 0.107 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 324.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 324.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0065 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0065 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0065 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114010,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1165.52       803.04       803.48      2917.46      2748.52
           ------------------------------------------------------------------------------
            DL+LL+Others     1165.52       803.04       803.48      2917.46      2748.52
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      803.04 kN-m.
           -. End Moments (My2) =      803.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      803.04 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      803.04 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2748.52 kN-m.
          -. End Moments (Mz2) =     2917.46 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2917.46 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2917.46 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1970.297 kN.
          -. Mry        =      1364.026 kN-m.
          -. Mrz        =      4938.447 kN-m.
          -. Mr         =      5123.360 kN-m.
          -. Pu/Pr      =   0.592  --->  O.K !
          -. Muy/Mry    =   0.589  --->  O.K !
          -. Muz/Mrz    =   0.591  --->  O.K !
          -. Mu/Mr      =   0.592  --->  O.K !
          -. Ratio      =   0.592  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2406.62 kN.
          -. Vuz    =         20.07 kN.
          -. Muy    =       -805.99 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.66 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.40

          -. Vuy    =        334.85 kN.
          -. Muz    =      -2901.04 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.05 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.31
```

( ). Compute shear strength of concrete.
-. Vuz = 20.07 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1085.07 kN.
-. phiVcz = phi * Vcz = 976.56 kN.

-. Vuy = 334.85 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1041.70 kN.
-. phiVcy = phi * Vcy = 937.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2031.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6063.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2031.56 kN.
-. phiVsz = phi*Vsz = 1828.41 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2002.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6106.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2002.02 kN.
-. phiVsy = phi*Vsy = 1801.82 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 335.447 kN.
-. Vr = 2739.345 kN.
-. Ratio = Vu / Vr = 0.122 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 372.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 372.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0061 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0062 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0062 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114011,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1177.50       803.48       786.78      2748.52      2550.12
           ---------------------------------------------------------------------------
            DL+LL+Others    1177.50       803.48       786.78      2748.52      2550.12
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      786.78 kN-m.
           -. End Moments (My2) =      803.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      803.48 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      803.48 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2550.12 kN-m.
          -. End Moments (Mz2) =     2748.52 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2748.52 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2748.52 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2097.795 kN.
          -. Mry        =      1437.634 kN-m.
          -. Mrz        =      4929.747 kN-m.
          -. Mr         =      5135.095 kN-m.
          -. Pu/Pr      =   0.561  --->  O.K !
          -. Muy/Mry    =   0.559  --->  O.K !
          -. Muz/Mrz    =   0.558  --->  O.K !
          -. Mu/Mr      =   0.561  --->  O.K !
          -. Ratio      =   0.561  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2423.28 kN.
          -. Vuz    =         42.57 kN.
          -. Muy    =       -804.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.43

          -. Vuy    =        393.10 kN.
          -. Muz    =      -2735.40 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.33
```

( ). Compute shear strength of concrete.
-. Vuz = 42.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1097.79 kN.
-. phiVcz = phi * Vcz = 988.02 kN.

-. Vuy = 393.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1054.41 kN.
-. phiVcy = phi * Vcy = 948.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2039.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6050.69 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2039.89 kN.
-. phiVsz = phi*Vsz = 1835.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2010.86 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6094.08 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2010.86 kN.
-. phiVsy = phi*Vsy = 1809.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 395.394 kN.
-. Vr = 2758.745 kN.
-. Ratio = Vu / Vr = 0.143 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 439.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 439.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0057 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0058 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0058 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114012,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1189.49       786.78       755.35      2550.12      2339.30
           ---------------------------------------------------------------------------
            DL+LL+Others    1189.49       786.78       755.35      2550.12      2339.30
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      755.35 kN-m.
           -. End Moments (My2) =      786.78 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      786.78 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      786.78 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2339.30 kN-m.
          -. End Moments (Mz2) =     2550.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2550.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2550.12 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2286.642 kN.
          -. Mry        =      1515.965 kN-m.
          -. Mrz        =      4916.865 kN-m.
          -. Mr         =      5145.261 kN-m.
          -. Pu/Pr      =   0.520  --->  O.K !
          -. Muy/Mry    =   0.519  --->  O.K !
          -. Muz/Mrz    =   0.519  --->  O.K !
          -. Mu/Mr      =   0.520  --->  O.K !
          -. Ratio      =   0.520  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2439.94 kN.
          -. Vuz    =         68.95 kN.
          -. Muy    =       -786.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47

          -. Vuy    =        436.91 kN.
          -. Muz    =      -2540.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 68.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1116.60 kN.
-. phiVcz = phi * Vcz = 1004.94 kN.

-. Vuy = 436.91 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1073.22 kN.
-. phiVcy = phi * Vcy = 965.89 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2051.94 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6031.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2051.94 kN.
-. phiVsz = phi*Vsz = 1846.75 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2023.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6075.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2023.67 kN.
-. phiVsy = phi*Vsy = 1821.30 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 442.314 kN.
-. Vr = 2787.193 kN.
-. Ratio = Vu / Vr = 0.159 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 491.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 491.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114013,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1201.48       755.35       711.87      2339.30      2118.91
           ---------------------------------------------------------------------------
            DL+LL+Others     1201.48       755.35       711.87      2339.30      2118.91
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      711.87 kN-m.
           -. End Moments (My2) =      755.35 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      755.35 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      755.35 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2118.91 kN-m.
          -. End Moments (Mz2) =     2339.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2339.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2339.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2532.274 kN.
          -. Mry        =      1585.249 kN-m.
          -. Mrz        =      4909.438 kN-m.
          -. Mr         =      5159.031 kN-m.
          -. Pu/Pr      =   0.474  --->  O.K !
          -. Muy/Mry    =   0.476  --->  O.K !
          -. Muz/Mrz    =   0.476  --->  O.K !
          -. Mu/Mr      =   0.476  --->  O.K !
          -. Ratio      =   0.476  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2456.60 kN.
          -. Vuz    =         90.84 kN.
          -. Muy    =       -753.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.52

          -. Vuy    =        465.61 kN.
          -. Muz    =      -2331.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.56 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.43
```

( ). Compute shear strength of concrete.
-. Vuz = 90.84 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1140.02 kN.
-. phiVcz = phi * Vcz = 1026.02 kN.

-. Vuy = 465.61 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1096.67 kN.
-. phiVcy = phi * Vcy = 987.00 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2066.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6008.47 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2066.52 kN.
-. phiVsz = phi*Vsz = 1859.87 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2039.16 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6051.82 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2039.16 kN.
-. phiVsy = phi*Vsy = 1835.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 474.387 kN.
-. Vr = 2822.252 kN.
-. Ratio = Vu / Vr = 0.168 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 527.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 527.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114014,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1213.47       711.87       659.12      2118.91      1888.56
           ------------------------------------------------------------------------------
            DL+LL+Others     1213.47       711.87       659.12      2118.91      1888.56
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      659.12 kN-m.
           -. End Moments (My2) =      711.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      711.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      711.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1888.56 kN-m.
          -. End Moments (Mz2) =     2118.91 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2118.91 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2118.91 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2814.275 kN.
          -. Mry        =      1636.140 kN-m.
          -. Mrz        =      4906.075 kN-m.
          -. Mr         =      5171.704 kN-m.
          -. Pu/Pr      =   0.431  --->  O.K !
          -. Muy/Mry    =   0.435  --->  O.K !
          -. Muz/Mrz    =   0.432  --->  O.K !
          -. Mu/Mr      =   0.435  --->  O.K !
          -. Ratio      =   0.435  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2473.26 kN.
          -. Vuz    =        107.57 kN.
          -. Muy    =       -708.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.00 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.59

          -. Vuy    =        479.37 kN.
          -. Muz    =      -2113.89 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.33 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.49
```

( ). Compute shear strength of concrete.
-. Vuz = 107.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1168.16 kN.
-. phiVcz = phi * Vcz = 1051.34 kN.

-. Vuy = 479.37 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1124.91 kN.
-. phiVcy = phi * Vcy = 1012.42 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2083.45 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5980.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2083.45 kN.
-. phiVsz = phi*Vsz = 1875.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2057.17 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6023.57 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2057.17 kN.
-. phiVsy = phi*Vsy = 1851.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 491.294 kN.
-. Vr = 2863.878 kN.
-. Ratio = Vu / Vr = 0.172 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 545.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 545.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114015,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1225.45       659.12       599.96      1888.56      1655.70
           ---------------------------------------------------------------------------
            DL+LL+Others     1225.45       659.12       599.96      1888.56      1655.70
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      599.96 kN-m.
           -. End Moments (My2) =      659.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      659.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      659.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1655.70 kN-m.
          -. End Moments (Mz2) =     1888.56 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1888.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1888.56 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      3205.577 kN.
          -. Mry        =      1709.591 kN-m.
          -. Mrz        =      4898.801 kN-m.
          -. Mr         =      5188.541 kN-m.
          -. Pu/Pr      =   0.382  --->  O.K !
          -. Muy/Mry    =   0.386  --->  O.K !
          -. Muz/Mrz    =   0.386  --->  O.K !
          -. Mu/Mr      =   0.386  --->  O.K !
          -. Ratio      =   0.386  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2489.92 kN.
          -. Vuz    =        119.56 kN.
          -. Muy    =       -655.40 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.66

          -. Vuy    =        478.98 kN.
          -. Muz    =      -1885.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.07 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56
```

( ). Compute shear strength of concrete.
-. Vuz = 119.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1201.53 kN.
-. phiVcz = phi * Vcz = 1081.37 kN.

-. Vuy = 478.98 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1158.48 kN.
-. phiVcy = phi * Vcy = 1042.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2102.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5946.96 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2102.73 kN.
-. phiVsz = phi*Vsz = 1892.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2077.70 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5990.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2077.70 kN.
-. phiVsy = phi*Vsy = 1869.93 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 493.681 kN.
-. Vr = 2912.559 kN.
-. Ratio = Vu / Vr = 0.170 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 548.53 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 548.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114016,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2506.58      -595.73      -532.52     -1654.43     -1427.75
           ---------------------------------------------------------------------------
            DL+LL+Others     2506.58      -595.73      -532.52     -1654.43     -1427.75
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      532.52 kN-m.
           -. End Moments (My2) =      595.73 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -595.73 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -595.73 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1427.75 kN-m.
          -. End Moments (Mz2) =     1654.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1654.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1654.43 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7250.635 kN.
          -. Mry        =      1727.835 kN-m.
          -. Mrz        =      4821.381 kN-m.
          -. Mr         =      5121.633 kN-m.
          -. Pu/Pr      =   0.346  --->  O.K !
          -. Muy/Mry    =   0.345  --->  O.K !
          -. Muz/Mrz    =   0.343  --->  O.K !
          -. Mu/Mr      =   0.346  --->  O.K !
          -. Ratio      =   0.346  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2506.58 kN.
          -. Vuz    =        126.64 kN.
          -. Muy    =       -595.73 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =        465.68 kN.
          -. Muz    =      -1654.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 126.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1239.48 kN.
-. phiVcz = phi * Vcz = 1115.53 kN.

-. Vuy = 465.68 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1196.75 kN.
-. phiVcy = phi * Vcy = 1077.07 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2123.68 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5909.01 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2123.68 kN.
-. phiVsz = phi*Vsz = 1911.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2100.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5951.74 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2100.02 kN.
-. phiVsy = phi*Vsy = 1890.02 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 482.596 kN.
-. Vr = 2967.094 kN.
-. Ratio = Vu / Vr = 0.163 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 536.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 536.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114017,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2523.24      -532.52      -468.23     -1427.75     -1211.33
           ------------------------------------------------------------------------------
            DL+LL+Others     2523.24      -532.52      -468.23     -1427.75     -1211.33
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      468.23 kN-m.
           -. End Moments (My2) =      532.52 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -532.52 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -532.52 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1211.33 kN-m.
          -. End Moments (Mz2) =     1427.75 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1427.75 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1427.75 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8333.237 kN.
          -. Mry        =      1752.292 kN-m.
          -. Mrz        =      4686.197 kN-m.
          -. Mr         =      5003.096 kN-m.
          -. Pu/Pr      =   0.303  --->  O.K !
          -. Muy/Mry    =   0.304  --->  O.K !
          -. Muz/Mrz    =   0.305  --->  O.K !
          -. Mu/Mr      =   0.305  --->  O.K !
          -. Ratio      =   0.305  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2523.24 kN.
          -. Vuz    =        128.76 kN.
          -. Muy    =       -532.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        441.03 kN.
          -. Muz    =      -1427.75 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 128.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1281.16 kN.
-. phiVcz = phi * Vcz = 1153.04 kN.

-. Vuy = 441.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1238.91 kN.
-. phiVcy = phi * Vcy = 1115.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2145.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5867.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2145.56 kN.
-. phiVsz = phi*Vsz = 1931.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5909.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.37 kN.
-. phiVsy = phi*Vsy = 1911.03 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 459.440 kN.
-. Vr = 3026.048 kN.
-. Ratio = Vu / Vr = 0.152 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 510.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 510.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114018,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2539.90      -468.23      -405.10     -1211.33     -1009.90
           ------------------------------------------------------------------------------
            DL+LL+Others     2539.90      -468.23      -405.10     -1211.33     -1009.90
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      405.10 kN-m.
           -. End Moments (My2) =      468.23 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -468.23 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -468.23 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1009.90 kN-m.
          -. End Moments (Mz2) =     1211.33 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1211.33 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1211.33 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9504.272 kN.
          -. Mry        =      1763.601 kN-m.
          -. Mrz        =      4546.031 kN-m.
          -. Mr         =      4876.135 kN-m.
          -. Pu/Pr      =   0.267  --->  O.K !
          -. Muy/Mry    =   0.265  --->  O.K !
          -. Muz/Mrz    =   0.266  --->  O.K !
          -. Mu/Mr      =   0.267  --->  O.K !
          -. Ratio      =   0.267  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2539.90 kN.
          -. Vuz    =        126.37 kN.
          -. Muy    =       -468.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.93

          -. Vuy    =        406.78 kN.
          -. Muz    =      -1211.33 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 126.37 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1325.64 kN.
-. phiVcz = phi * Vcz = 1193.07 kN.

-. Vuy = 406.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1284.05 kN.
-. phiVcy = phi * Vcy = 1155.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2167.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5822.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2167.73 kN.
-. phiVsz = phi*Vsz = 1950.95 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2147.04 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5864.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2147.04 kN.
-. phiVsy = phi*Vsy = 1932.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 425.955 kN.
-. Vr = 3087.976 kN.
-. Ratio = Vu / Vr = 0.138 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 473.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 473.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114019,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2556.56      -405.10      -345.11     -1009.90      -827.35
           ------------------------------------------------------------------------------
            DL+LL+Others     2556.56      -405.10      -345.11     -1009.90      -827.35
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      345.11 kN-m.
           -. End Moments (My2) =      405.10 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -405.10 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -405.10 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      827.35 kN-m.
          -. End Moments (Mz2) =     1009.90 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1009.90 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1009.90 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11139.819 kN.
          -. Mry        =      1754.326 kN-m.
          -. Mrz        =      4388.959 kN-m.
          -. Mr         =      4726.586 kN-m.
          -. Pu/Pr      =   0.229  --->  O.K !
          -. Muy/Mry    =   0.231  --->  O.K !
          -. Muz/Mrz    =   0.230  --->  O.K !
          -. Mu/Mr      =   0.231  --->  O.K !
          -. Ratio      =   0.231  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2556.56 kN.
          -. Vuz    =        120.05 kN.
          -. Muy    =       -405.10 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        367.15 kN.
          -. Muz    =      -1009.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 120.05 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1371.47 kN.
-. phiVcz = phi * Vcz = 1234.33 kN.

-. Vuy = 367.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1330.71 kN.
-. phiVcy = phi * Vcy = 1197.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2189.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5777.01 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2189.37 kN.
-. phiVsz = phi*Vsz = 1970.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2170.18 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5817.77 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2170.18 kN.
-. phiVsy = phi*Vsy = 1953.16 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 386.278 kN.
-. Vr = 3150.803 kN.
-. Ratio = Vu / Vr = 0.123 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 429.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 429.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =9.4787e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0001 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114020,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2573.22      -345.11      -289.93      -827.35      -667.32
           ------------------------------------------------------------------------------
            DL+LL+Others     2573.22      -345.11      -289.93      -827.35      -667.32
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      289.93 kN-m.
           -. End Moments (My2) =      345.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -345.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -345.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      667.32 kN-m.
          -. End Moments (Mz2) =      827.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -827.35 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -827.35 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     12969.759 kN.
           -. Mry        =      1743.651 kN-m.
           -. Mrz        =      4194.303 kN-m.
           -. Mr         =      4542.300 kN-m.
           -. Pu/Pr      =   0.198  --->  O.K !
           -. Muy/Mry    =   0.198  --->  O.K !
           -. Muz/Mrz    =   0.197  --->  O.K !
           -. Mu/Mr      =   0.198  --->  O.K !
           -. Ratio      =   0.198  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2573.22 kN.
           -. Vuz    =        110.41 kN.
           -. Muy    =       -345.11 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.47 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.14

           -. Vuy    =        321.91 kN.
           -. Muz    =       -827.35 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.68 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.05
```

( ). Compute shear strength of concrete.
-. Vuz = 110.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1417.72 kN.
-. phiVcz = phi * Vcz = 1275.94 kN.

-. Vuy = 321.91 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1377.96 kN.
-. phiVcy = phi * Vcy = 1240.16 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2210.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5730.77 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2210.08 kN.
-. phiVsz = phi*Vsz = 1989.07 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2192.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5770.53 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2192.34 kN.
-. phiVsy = phi*Vsy = 1973.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 340.319 kN.
-. Vr = 3213.268 kN.
-. Ratio = Vu / Vr = 0.106 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 378.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 378.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114021,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2589.88      -289.93      -240.63      -667.32      -530.92
           ------------------------------------------------------------------------------
            DL+LL+Others     2589.88      -289.93      -240.63      -667.32      -530.92
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      240.63 kN-m.
           -. End Moments (My2) =      289.93 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -289.93 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -289.93 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      530.92 kN-m.
          -. End Moments (Mz2) =      667.32 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -667.32 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -667.32 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15252.935 kN.
          -. Mry        =      1694.499 kN-m.
          -. Mrz        =      3903.435 kN-m.
          -. Mr         =      4255.365 kN-m.
          -. Pu/Pr      =   0.170  --->  O.K !
          -. Muy/Mry    =   0.171  --->  O.K !
          -. Muz/Mrz    =   0.171  --->  O.K !
          -. Mu/Mr      =   0.171  --->  O.K !
          -. Ratio      =   0.171  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2589.88 kN.
          -. Vuz    =         98.60 kN.
          -. Muy    =       -289.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.25 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.24

          -. Vuy    =        274.03 kN.
          -. Muz    =       -667.32 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.15
```

( ). Compute shear strength of concrete.
-. Vuz = 98.60 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1462.61 kN.
-. phiVcz = phi * Vcz = 1316.35 kN.

-. Vuy = 274.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1423.98 kN.
-. phiVcy = phi * Vcy = 1281.58 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2229.18 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5685.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2229.18 kN.
-. phiVsz = phi*Vsz = 2006.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2212.80 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5724.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2212.80 kN.
-. phiVsy = phi*Vsy = 1991.52 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 291.230 kN.
-. Vr = 3273.102 kN.
-. Ratio = Vu / Vr = 0.089 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 323.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 323.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0013 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0013 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114022,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2606.53      -240.63      -196.45      -530.92      -413.15
           ------------------------------------------------------------------------------
            DL+LL+Others     2606.53      -240.63      -196.45      -530.92      -413.15
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      196.45 kN-m.
           -. End Moments (My2) =      240.63 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -240.63 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -240.63 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      413.15 kN-m.
          -. End Moments (Mz2) =      530.92 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -530.92 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -530.92 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17428.112 kN.
          -. Mry        =      1615.128 kN-m.
          -. Mrz        =      3566.573 kN-m.
          -. Mr         =      3915.237 kN-m.
          -. Pu/Pr      =   0.150  --->  O.K !
          -. Muy/Mry    =   0.149  --->  O.K !
          -. Muz/Mrz    =   0.149  --->  O.K !
          -. Mu/Mr      =   0.150  --->  O.K !
          -. Ratio      =   0.150  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2606.53 kN.
          -. Vuz    =         88.38 kN.
          -. Muy    =       -240.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.33

          -. Vuy    =        236.40 kN.
          -. Muz    =       -530.92 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.24 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.24
```

( ). Compute shear strength of concrete.
-. Vuz = 88.38 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1502.49 kN.
-. phiVcz = phi * Vcz = 1352.24 kN.

-. Vuy = 236.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1464.99 kN.
-. phiVcy = phi * Vcy = 1318.49 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2245.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5646.00 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2245.37 kN.
-. phiVsz = phi*Vsz = 2020.84 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2230.16 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5683.50 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2230.16 kN.
-. phiVsy = phi*Vsy = 2007.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 252.376 kN.
-. Vr = 3325.637 kN.
-. Ratio = Vu / Vr = 0.076 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 280.42 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 280.42 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114023,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3406.73       -50.75       -40.70       -80.25       -66.73
           ------------------------------------------------------------------------------
            DL+LL+Others     3406.73       -50.75       -40.70       -80.25       -66.73
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       40.70 kN-m.
           -. End Moments (My2) =       50.75 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -40.70 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -40.70 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       66.73 kN-m.
          -. End Moments (Mz2) =       80.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -66.73 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -66.73 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =       291.645 kN-m.
           -. Mrz        =       477.965 kN-m.
           -. Mr         =       559.917 kN-m.
           -. Pu/Pr      =   0.140  --->  O.K !
           -. Muy/Mry    =   0.140  --->  O.K !
           -. Muz/Mrz    =   0.140  --->  O.K !
           -. Mu/Mr      =   0.140  --->  O.K !
           -. Ratio      =   0.140  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2623.19 kN.
           -. Vuz    =         77.49 kN.
           -. Muy    =       -196.45 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  30.91 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.41

           -. Vuy    =        199.10 kN.
           -. Muz    =       -413.15 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.06 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.33
```

( ). Compute shear strength of concrete.
-. Vuz = 77.49 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1539.71 kN.
-. phiVcz = phi * Vcz = 1385.74 kN.

-. Vuy = 199.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1503.39 kN.
-. phiVcy = phi * Vcy = 1353.05 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2259.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5608.77 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2259.88 kN.
-. phiVsz = phi*Vsz = 2033.89 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2245.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5645.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2245.73 kN.
-. phiVsy = phi*Vsy = 2021.16 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 213.646 kN.
-. Vr = 3374.203 kN.
-. Ratio = Vu / Vr = 0.063 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 237.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 237.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114024,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3423.38       -40.70       -32.12       -66.73       -54.68
           ------------------------------------------------------------------------------
            DL+LL+Others     3423.38       -40.70       -32.12       -66.73       -54.68
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       32.12 kN-m.
           -. End Moments (My2) =       40.70 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -32.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -32.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       54.68 kN-m.
          -. End Moments (Mz2) =       66.73 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -54.68 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -54.68 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       229.038 kN-m.
          -. Mrz        =       389.757 kN-m.
          -. Mr         =       452.072 kN-m.
          -. Pu/Pr      =   0.140  --->  O.K !
          -. Muy/Mry    =   0.140  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.140  --->  O.K !
          -. Ratio      =   0.140  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2639.85 kN.
          -. Vuz    =         66.37 kN.
          -. Muy    =       -157.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.48

          -. Vuy    =        162.97 kN.
          -. Muz    =       -313.95 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.41
```

( ). Compute shear strength of concrete.
-. Vuz = 66.37 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1573.51 kN.
-. phiVcz = phi * Vcz = 1416.16 kN.

-. Vuy = 162.97 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1538.34 kN.
-. phiVcy = phi * Vcy = 1384.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2272.57 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5574.97 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2272.57 kN.
-. phiVsz = phi*Vsz = 2045.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2259.35 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5610.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2259.35 kN.
-. phiVsy = phi*Vsy = 2033.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 175.966 kN.
-. Vr = 3417.921 kN.
-. Ratio = Vu / Vr = 0.051 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 195.52 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 195.52 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114025,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3440.04       -32.12       -24.98       -54.68       -44.17
           ------------------------------------------------------------------------------
            DL+LL+Others     3440.04       -32.12       -24.98       -54.68       -44.17
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       24.98 kN-m.
           -. End Moments (My2) =       32.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -24.98 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -24.98 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       44.17 kN-m.
          -. End Moments (Mz2) =       54.68 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -44.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -44.17 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       177.130 kN-m.
          -. Mrz        =       313.428 kN-m.
          -. Mr         =       360.017 kN-m.
          -. Pu/Pr      =   0.141  --->  O.K !
          -. Muy/Mry    =   0.141  --->  O.K !
          -. Muz/Mrz    =   0.141  --->  O.K !
          -. Mu/Mr      =   0.141  --->  O.K !
          -. Ratio      =   0.141  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2656.51 kN.
          -. Vuz    =         55.36 kN.
          -. Muy    =       -124.54 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.55

          -. Vuy    =        128.76 kN.
          -. Muz    =       -232.78 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.47
```

( ). Compute shear strength of concrete.
-. Vuz = 55.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1603.24 kN.
-. phiVcz = phi * Vcz = 1442.92 kN.

-. Vuy = 128.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1569.15 kN.
-. phiVcy = phi * Vcy = 1412.24 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2283.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5545.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2283.37 kN.
-. phiVsz = phi*Vsz = 2055.03 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2270.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5579.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2270.96 kN.
-. phiVsy = phi*Vsy = 2043.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 140.154 kN.
-. Vr = 3456.099 kN.
-. Ratio = Vu / Vr = 0.041 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 155.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 155.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114026,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3456.69       -24.98       -18.82       -44.17       -34.78
           ------------------------------------------------------------------------------
            DL+LL+Others     3456.69       -24.98       -18.82       -44.17       -34.78
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       18.82 kN-m.
           -. End Moments (My2) =       24.98 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -18.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -18.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       34.78 kN-m.
          -. End Moments (Mz2) =       44.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -34.78 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -34.78 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       132.658 kN-m.
          -. Mrz        =       245.692 kN-m.
          -. Mr         =       279.218 kN-m.
          -. Pu/Pr      =   0.142  --->  O.K !
          -. Muy/Mry    =   0.142  --->  O.K !
          -. Muz/Mrz    =   0.142  --->  O.K !
          -. Mu/Mr      =   0.142  --->  O.K !
          -. Ratio      =   0.142  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2673.17 kN.
          -. Vuz    =         47.80 kN.
          -. Muy    =        -96.86 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.60

          -. Vuy    =        106.12 kN.
          -. Muz    =       -168.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.53
```

( ). Compute shear strength of concrete.
-. Vuz = 47.80 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1626.15 kN.
-. phiVcz = phi * Vcz = 1463.53 kN.

-. Vuy = 106.12 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1592.95 kN.
-. phiVcy = phi * Vcy = 1433.65 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2291.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5522.34 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2291.47 kN.
-. phiVsz = phi*Vsz = 2062.32 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2279.66 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5555.54 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2279.66 kN.
-. phiVsy = phi*Vsy = 2051.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 116.387 kN.
-. Vr = 3485.349 kN.
-. Ratio = Vu / Vr = 0.033 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 129.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 129.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114027,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3473.35       -18.82       -13.49       -34.78       -26.38
           ------------------------------------------------------------------------------
            DL+LL+Others     3473.35       -18.82       -13.49       -34.78       -26.38
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.49 kN-m.
           -. End Moments (My2) =       18.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.49 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.49 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       26.38 kN-m.
          -. End Moments (Mz2) =       34.78 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -26.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -26.38 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        94.957 kN-m.
          -. Mrz        =       185.236 kN-m.
          -. Mr         =       208.157 kN-m.
          -. Pu/Pr      =   0.142  --->  O.K !
          -. Muy/Mry    =   0.142  --->  O.K !
          -. Muz/Mrz    =   0.142  --->  O.K !
          -. Mu/Mr      =   0.142  --->  O.K !
          -. Ratio      =   0.142  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2689.82 kN.
          -. Vuz    =         41.38 kN.
          -. Muy    =        -72.97 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =         87.56 kN.
          -. Muz    =       -116.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 41.38 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1645.21 kN.
-. phiVcz = phi * Vcz = 1480.69 kN.

-. Vuy = 87.56 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1612.78 kN.
-. phiVcy = phi * Vcy = 1451.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2298.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5503.27 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2298.07 kN.
-. phiVsz = phi*Vsz = 2068.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.76 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5535.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.76 kN.
-. phiVsy = phi*Vsy = 2058.09 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 96.842 kN.
-. Vr = 3509.588 kN.
-. Ratio = Vu / Vr = 0.028 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 107.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 107.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114028,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3490.01       -13.49        -8.90       -26.38       -18.90
           ------------------------------------------------------------------------------
            DL+LL+Others     3490.01       -13.49        -8.90       -26.38       -18.90
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.90 kN-m.
           -. End Moments (My2) =       13.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       18.90 kN-m.
          -. End Moments (Mz2) =       26.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -18.90 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -18.90 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        62.242 kN-m.
          -. Mrz        =       132.162 kN-m.
          -. Mr         =       146.085 kN-m.
          -. Pu/Pr      =   0.143  --->  O.K !
          -. Muy/Mry    =   0.143  --->  O.K !
          -. Muz/Mrz    =   0.143  --->  O.K !
          -. Mu/Mr      =   0.143  --->  O.K !
          -. Ratio      =   0.143  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2706.48 kN.
          -. Vuz    =         35.63 kN.
          -. Muy    =        -52.29 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.68

          -. Vuy    =         71.46 kN.
          -. Muz    =        -72.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 35.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1661.13 kN.
-. phiVcz = phi * Vcz = 1495.02 kN.

-. Vuy = 71.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1629.36 kN.
-. phiVcy = phi * Vcy = 1466.42 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2303.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5487.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2303.49 kN.
-. phiVsz = phi*Vsz = 2073.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2292.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5519.13 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2292.59 kN.
-. phiVsy = phi*Vsy = 2063.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 79.850 kN.
-. Vr = 3529.752 kN.
-. Ratio = Vu / Vr = 0.023 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 88.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 88.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114029,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3506.66        -8.90        -4.96       -18.90       -12.52
           ------------------------------------------------------------------------------
            DL+LL+Others     3506.66        -8.90        -4.96       -18.90       -12.52
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.96 kN-m.
           -. End Moments (My2) =        8.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       12.52 kN-m.
          -. End Moments (Mz2) =       18.90 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -12.52 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -12.52 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        34.566 kN-m.
          -. Mrz        =        87.128 kN-m.
          -. Mr         =        93.734 kN-m.
          -. Pu/Pr      =   0.144  --->  O.K !
          -. Muy/Mry    =   0.143  --->  O.K !
          -. Muz/Mrz    =   0.144  --->  O.K !
          -. Mu/Mr      =   0.144  --->  O.K !
          -. Ratio      =   0.144  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2757.48 kN.
          -. Vuz    =         59.92 kN.
          -. Muy    =        -65.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.41 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.68

          -. Vuy    =         27.54 kN.
          -. Muz    =        -21.84 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.53 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 59.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1664.19 kN.
-. phiVcz = phi * Vcz = 1497.77 kN.

-. Vuy = 27.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1632.55 kN.
-. phiVcy = phi * Vcy = 1469.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2304.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5484.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2304.52 kN.
-. phiVsz = phi*Vsz = 2074.07 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2293.70 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5515.93 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2293.70 kN.
-. phiVsy = phi*Vsy = 2064.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 65.944 kN.
-. Vr = 3533.627 kN.
-. Ratio = Vu / Vr = 0.019 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 73.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 73.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114030,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3523.32        -4.96        -2.12       -12.52        -9.61
           ------------------------------------------------------------------------------
            DL+LL+Others     3523.32        -4.96        -2.12       -12.52        -9.61
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.12 kN-m.
           -. End Moments (My2) =        4.96 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        9.61 kN-m.
          -. End Moments (Mz2) =       12.52 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -9.61 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -9.61 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        14.729 kN-m.
          -. Mrz        =        66.555 kN-m.
          -. Mr         =        68.166 kN-m.
          -. Pu/Pr      =   0.144  --->  O.K !
          -. Muy/Mry    =   0.144  --->  O.K !
          -. Muz/Mrz    =   0.144  --->  O.K !
          -. Mu/Mr      =   0.144  --->  O.K !
          -. Ratio      =   0.144  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2790.80 kN.
          -. Vuz    =         43.51 kN.
          -. Muy    =        -13.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.70

          -. Vuy    =         18.14 kN.
          -. Muz    =        -13.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.63
```

( ). Compute shear strength of concrete.
-. Vuz = 43.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1673.14 kN.
-. phiVcz = phi * Vcz = 1505.83 kN.

-. Vuy = 18.14 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1641.88 kN.
-. phiVcy = phi * Vcy = 1477.69 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2307.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5475.35 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2307.52 kN.
-. phiVsz = phi*Vsz = 2076.77 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2296.93 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5506.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2296.93 kN.
-. phiVsy = phi*Vsy = 2067.23 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 47.143 kN.
-. Vr = 3544.927 kN.
-. Ratio = Vu / Vr = 0.013 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 52.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 52.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0043 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0043 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114031,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3539.97        -2.12        -0.93        -9.61        -7.18
           ------------------------------------------------------------------------------
            DL+LL+Others     3539.97        -2.12        -0.93        -9.61        -7.18
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.93 kN-m.
           -. End Moments (My2) =        2.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.93 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.93 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        7.18 kN-m.
          -. End Moments (Mz2) =        9.61 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -7.18 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -7.18 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         6.483 kN-m.
          -. Mrz        =        49.527 kN-m.
          -. Mr         =        49.950 kN-m.
          -. Pu/Pr      =   0.145  --->  O.K !
          -. Muy/Mry    =   0.144  --->  O.K !
          -. Muz/Mrz    =   0.145  --->  O.K !
          -. Mu/Mr      =   0.145  --->  O.K !
          -. Ratio      =   0.145  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2807.45 kN.
          -. Vuz    =         24.12 kN.
          -. Muy    =         -1.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.35 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.72

          -. Vuy    =          8.00 kN.
          -. Muz    =        -13.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.66
```

( ). Compute shear strength of concrete.
-. Vuz = 24.12 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1682.21 kN.
-. phiVcz = phi * Vcz = 1513.99 kN.

-. Vuy = 8.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1651.34 kN.
-. phiVcy = phi * Vcy = 1486.21 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2310.53 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5466.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2310.53 kN.
-. phiVsz = phi*Vsz = 2079.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2300.17 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5497.14 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2300.17 kN.
-. phiVsy = phi*Vsy = 2070.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 25.409 kN.
-. Vr = 3556.358 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 28.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 28.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114032,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3556.63        -0.93        -0.84        -7.18        -4.67
           ------------------------------------------------------------------------------
            DL+LL+Others     3556.63        -0.93        -0.84        -7.18        -4.67
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.84 kN-m.
           -. End Moments (My2) =        0.93 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.84 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.84 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.67 kN-m.
          -. End Moments (Mz2) =        7.18 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.67 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.67 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         5.755 kN-m.
          -. Mrz        =        32.016 kN-m.
          -. Mr         =        32.529 kN-m.
          -. Pu/Pr      =   0.146  --->  O.K !
          -. Muy/Mry    =   0.146  --->  O.K !
          -. Muz/Mrz    =   0.146  --->  O.K !
          -. Mu/Mr      =   0.146  --->  O.K !
          -. Ratio      =   0.146  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2789.77 kN.
          -. Vuz    =          5.46 kN.
          -. Muy    =         -1.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.74

          -. Vuy    =         10.85 kN.
          -. Muz    =        -20.29 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.67
```

( ). Compute shear strength of concrete.
-. Vuz = 5.46 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1688.45 kN.
-. phiVcz = phi * Vcz = 1519.60 kN.

-. Vuy = 10.85 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1657.86 kN.
-. phiVcy = phi * Vcy = 1492.07 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2312.59 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5460.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2312.59 kN.
-. phiVsz = phi*Vsz = 2081.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2302.38 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5490.63 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2302.38 kN.
-. phiVsy = phi*Vsy = 2072.14 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 12.148 kN.
-. Vr = 3564.217 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 13.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 13.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114033,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3573.28        -0.84        -0.54        -4.67        -2.37
           ------------------------------------------------------------------------------
            DL+LL+Others     3573.28        -0.84        -0.54        -4.67        -2.37
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.54 kN-m.
           -. End Moments (My2) =        0.84 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        2.37 kN-m.
          -. End Moments (Mz2) =        4.67 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -2.37 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -2.37 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         3.716 kN-m.
          -. Mrz        =        16.192 kN-m.
          -. Mr         =        16.613 kN-m.
          -. Pu/Pr      =   0.146  --->  O.K !
          -. Muy/Mry    =   0.146  --->  O.K !
          -. Muz/Mrz    =   0.146  --->  O.K !
          -. Mu/Mr      =   0.146  --->  O.K !
          -. Ratio      =   0.146  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2806.42 kN.
          -. Vuz    =          0.83 kN.
          -. Muy    =         -1.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.73

          -. Vuy    =         16.78 kN.
          -. Muz    =        -11.92 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.67
```

( ). Compute shear strength of concrete.
-. Vuz = 0.83 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1686.82 kN.
-. phiVcz = phi * Vcz = 1518.14 kN.

-. Vuy = 16.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1656.16 kN.
-. phiVcy = phi * Vcy = 1490.54 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2312.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5461.67 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2312.05 kN.
-. phiVsz = phi*Vsz = 2080.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2301.81 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5492.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2301.81 kN.
-. phiVsy = phi*Vsy = 2071.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 16.796 kN.
-. Vr = 3562.169 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 18.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 18.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114034,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3589.94        -0.54        -0.19        -2.37        -0.69
           ------------------------------------------------------------------------------
            DL+LL+Others     3589.94        -0.54        -0.19        -2.37        -0.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.19 kN-m.
           -. End Moments (My2) =        0.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.19 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.19 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.69 kN-m.
          -. End Moments (Mz2) =        2.37 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         1.288 kN-m.
          -. Mrz        =         4.680 kN-m.
          -. Mr         =         4.855 kN-m.
          -. Pu/Pr      =   0.147  --->  O.K !
          -. Muy/Mry    =   0.147  --->  O.K !
          -. Muz/Mrz    =   0.147  --->  O.K !
          -. Mu/Mr      =   0.147  --->  O.K !
          -. Ratio      =   0.147  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2823.08 kN.
          -. Vuz    =          1.69 kN.
          -. Muy    =         -0.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.34 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.73

          -. Vuy    =         16.01 kN.
          -. Muz    =         -3.92 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.45 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.66
```

( ). Compute shear strength of concrete.
-. Vuz = 1.69 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1685.01 kN.
-. phiVcz = phi * Vcz = 1516.51 kN.

-. Vuy = 16.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1654.27 kN.
-. phiVcy = phi * Vcy = 1488.85 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2311.46 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5463.47 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2311.46 kN.
-. phiVsz = phi*Vsz = 2080.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2301.16 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5494.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2301.16 kN.
-. phiVsy = phi*Vsy = 2071.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 16.102 kN.
-. Vr = 3559.893 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.89 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.89 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114035,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3606.60        -0.19         0.00        -0.69         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3606.60        -0.19         0.00        -0.69         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.19 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.148  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.148  --->  O.K !
          -. Ratio      =   0.148  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2839.73 kN.
          -. Vuz    =          1.36 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.44 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.67

          -. Vuy    =          7.84 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.67
```

( ). Compute shear strength of concrete.
-. Vuz = 1.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1656.44 kN.
-. phiVcz = phi * Vcz = 1490.80 kN.

-. Vuy = 7.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1656.44 kN.
-. phiVcy = phi * Vcy = 1490.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2301.90 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5492.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2301.90 kN.
-. phiVsz = phi*Vsz = 2071.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2301.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5492.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2301.90 kN.
-. phiVsy = phi*Vsy = 2071.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 7.953 kN.
-. Vr = 3562.508 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 8.84 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 8.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115002,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            899.98       549.21       640.12      2586.06      2770.05
           ------------------------------------------------------------------------------
            DL+LL+Others      899.98       549.21       640.12      2586.06      2770.05
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      549.21 kN-m.
           -. End Moments (My2) =      640.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      640.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      640.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2586.06 kN-m.
          -. End Moments (Mz2) =     2770.05 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2770.05 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2770.05 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1624.141 kN.
          -. Mry        =      1145.373 kN-m.
          -. Mrz        =      4974.402 kN-m.
          -. Mr         =      5104.562 kN-m.
          -. Pu/Pr      =   0.554  --->  O.K !
          -. Muy/Mry    =   0.559  --->  O.K !
          -. Muz/Mrz    =   0.557  --->  O.K !
          -. Mu/Mr      =   0.559  --->  O.K !
          -. Ratio      =   0.559  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2441.56 kN.
          -. Vuz    =        199.52 kN.
          -. Muy    =       -646.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42

          -. Vuy    =        439.24 kN.
          -. Muz    =      -2738.44 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.98 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.32
```

( ). Compute shear strength of concrete.
-. Vuz = 199.52 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1091.99 kN.
-. phiVcz = phi * Vcz = 982.80 kN.

-. Vuy = 439.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1048.61 kN.
-. phiVcy = phi * Vcy = 943.75 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2036.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6056.49 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2036.11 kN.
-. phiVsz = phi*Vsz = 1832.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2006.85 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6099.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2006.85 kN.
-. phiVsy = phi*Vsy = 1806.16 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 482.429 kN.
-. Vr = 2749.916 kN.
-. Ratio = Vu / Vr = 0.175 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 536.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 536.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0058 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0058 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0058 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115003,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            911.95       640.12       716.26      2770.05      2904.31
           ------------------------------------------------------------------------------
            DL+LL+Others      911.95       640.12       716.26      2770.05      2904.31
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      640.12 kN-m.
           -. End Moments (My2) =      716.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      716.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      716.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2770.05 kN-m.
          -. End Moments (Mz2) =     2904.31 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2904.31 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2904.31 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1550.494 kN.
          -. Mry        =      1216.378 kN-m.
          -. Mrz        =      4951.494 kN-m.
          -. Mr         =      5098.712 kN-m.
          -. Pu/Pr      =   0.588  --->  O.K !
          -. Muy/Mry    =   0.589  --->  O.K !
          -. Muz/Mrz    =   0.587  --->  O.K !
          -. Mu/Mr      =   0.589  --->  O.K !
          -. Ratio      =   0.589  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2458.24 kN.
          -. Vuz    =        165.11 kN.
          -. Muy    =       -726.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.67 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.40

          -. Vuy    =        337.77 kN.
          -. Muz    =      -2875.45 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.30
```

( ). Compute shear strength of concrete.
-. Vuz = 165.11 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1083.56 kN.
-. phiVcz = phi * Vcz = 975.21 kN.

-. Vuy = 337.77 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1040.19 kN.
-. phiVcy = phi * Vcy = 936.18 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2030.57 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6064.92 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2030.57 kN.
-. phiVsz = phi*Vsz = 1827.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2000.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6108.29 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2000.96 kN.
-. phiVsy = phi*Vsy = 1800.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 375.963 kN.
-. Vr = 2737.038 kN.
-. Ratio = Vu / Vr = 0.137 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 417.74 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 417.74 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0060 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0060 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0060 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115004,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            923.92       716.26       779.22      2904.31      2991.78
           ---------------------------------------------------------------------------
            DL+LL+Others      923.92       716.26       779.22      2904.31      2991.78
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      716.26 kN-m.
           -. End Moments (My2) =      779.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      779.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      779.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2904.31 kN-m.
          -. End Moments (Mz2) =     2991.78 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2991.78 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2991.78 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1529.852 kN.
          -. Mry        =      1271.333 kN-m.
          -. Mrz        =      4941.325 kN-m.
          -. Mr         =      5102.252 kN-m.
          -. Pu/Pr      =   0.604  --->  O.K !
          -. Muy/Mry    =   0.613  --->  O.K !
          -. Muz/Mrz    =   0.605  --->  O.K !
          -. Mu/Mr      =   0.613  --->  O.K !
          -. Ratio      =   0.613  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2698.07 kN.
          -. Vuz    =        279.41 kN.
          -. Muy    =      -1626.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.64

          -. Vuy    =        122.55 kN.
          -. Muz    =      -1350.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.12 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.55
```

( ). Compute shear strength of concrete.
-. Vuz = 279.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1194.76 kN.
-. phiVcz = phi * Vcz = 1075.29 kN.

-. Vuy = 122.55 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1151.67 kN.
-. phiVcy = phi * Vcy = 1036.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2098.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5953.72 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2098.89 kN.
-. phiVsz = phi*Vsz = 1889.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2073.61 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5996.82 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2073.61 kN.
-. phiVsy = phi*Vsy = 1866.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 305.102 kN.
-. Vr = 2902.745 kN.
-. Ratio = Vu / Vr = 0.105 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 339.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 339.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115005,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            935.90       779.22       828.09      2991.78      3035.95
           ------------------------------------------------------------------------------
            DL+LL+Others      935.90       779.22       828.09      2991.78      3035.95
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      779.22 kN-m.
           -. End Moments (My2) =      828.09 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      828.09 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      828.09 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2991.78 kN-m.
          -. End Moments (Mz2) =     3035.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3035.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3035.95 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1508.233 kN.
          -. Mry        =      1329.695 kN-m.
          -. Mrz        =      4922.707 kN-m.
          -. Mr         =      5099.131 kN-m.
          -. Pu/Pr      =   0.621  --->  O.K !
          -. Muy/Mry    =   0.623  --->  O.K !
          -. Muz/Mrz    =   0.617  --->  O.K !
          -. Mu/Mr      =   0.623  --->  O.K !
          -. Ratio      =   0.623  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2714.77 kN.
          -. Vuz    =        214.63 kN.
          -. Muy    =      -1734.30 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =         83.16 kN.
          -. Muz    =      -1363.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 214.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1189.52 kN.
-. phiVcz = phi * Vcz = 1070.57 kN.

-. Vuy = 83.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1146.39 kN.
-. phiVcy = phi * Vcy = 1031.75 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2095.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5958.97 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2095.89 kN.
-. phiVsz = phi*Vsz = 1886.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2070.41 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6002.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2070.41 kN.
-. phiVsy = phi*Vsy = 1863.37 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 230.172 kN.
-. Vr = 2895.124 kN.
-. Ratio = Vu / Vr = 0.080 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 255.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 255.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115006,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            947.87       828.09       863.91      3035.95      3040.78
           ------------------------------------------------------------------------------
            DL+LL+Others      947.87       828.09       863.91      3035.95      3040.78
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      828.09 kN-m.
           -. End Moments (My2) =      863.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      863.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      863.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3035.95 kN-m.
          -. End Moments (Mz2) =     3040.78 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3040.78 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3040.78 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1535.847 kN.
          -. Mry        =      1384.448 kN-m.
          -. Mrz        =      4907.952 kN-m.
          -. Mr         =      5099.479 kN-m.
          -. Pu/Pr      =   0.617  --->  O.K !
          -. Muy/Mry    =   0.624  --->  O.K !
          -. Muz/Mrz    =   0.620  --->  O.K !
          -. Mu/Mr      =   0.624  --->  O.K !
          -. Ratio      =   0.624  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2731.46 kN.
          -. Vuz    =        154.47 kN.
          -. Muy    =      -1813.20 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =         52.00 kN.
          -. Muz    =      -1359.37 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53
```

( ). Compute shear strength of concrete.
-. Vuz = 154.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1188.11 kN.
-. phiVcz = phi * Vcz = 1069.30 kN.

-. Vuy = 52.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1144.98 kN.
-. phiVcy = phi * Vcy = 1030.48 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2095.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5960.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2095.08 kN.
-. phiVsz = phi*Vsz = 1885.57 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2069.55 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6003.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2069.55 kN.
-. phiVsy = phi*Vsy = 1862.60 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 162.986 kN.
-. Vr = 2893.074 kN.
-. Ratio = Vu / Vr = 0.056 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 181.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 181.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115007,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            947.86       863.91       884.62      3040.78      3004.98
           ------------------------------------------------------------------------------
            DL+LL+Others      947.86       863.91       884.62      3040.78      3004.98
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      863.91 kN-m.
           -. End Moments (My2) =      884.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      863.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      863.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     3004.98 kN-m.
          -. End Moments (Mz2) =     3040.78 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3040.78 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3040.78 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1535.847 kN.
          -. Mry        =      1384.448 kN-m.
          -. Mrz        =      4907.952 kN-m.
          -. Mr         =      5099.479 kN-m.
          -. Pu/Pr      =   0.617  --->  O.K !
          -. Muy/Mry    =   0.624  --->  O.K !
          -. Muz/Mrz    =   0.620  --->  O.K !
          -. Mu/Mr      =   0.624  --->  O.K !
          -. Ratio      =   0.624  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2748.16 kN.
          -. Vuz    =         90.74 kN.
          -. Muy    =      -1859.89 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.64

          -. Vuy    =         49.25 kN.
          -. Muz    =      -1337.99 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 90.74 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1191.03 kN.
-. phiVcz = phi * Vcz = 1071.93 kN.

-. Vuy = 49.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1147.91 kN.
-. phiVcy = phi * Vcy = 1033.12 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2096.76 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5957.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2096.76 kN.
-. phiVsz = phi*Vsz = 1887.08 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2071.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6000.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2071.34 kN.
-. phiVsy = phi*Vsy = 1864.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 103.247 kN.
-. Vr = 2897.320 kN.
-. Ratio = Vu / Vr = 0.036 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 114.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 114.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115008,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            959.83       884.62       883.05      3004.98      2911.35
           ------------------------------------------------------------------------------
            DL+LL+Others      959.83       884.62       883.05      3004.98      2911.35
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      883.05 kN-m.
           -. End Moments (My2) =      884.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      884.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      884.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2911.35 kN-m.
          -. End Moments (Mz2) =     3004.98 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     3004.98 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     3004.98 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1562.501 kN.
          -. Mry        =      1433.568 kN-m.
          -. Mrz        =      4894.343 kN-m.
          -. Mr         =      5099.972 kN-m.
          -. Pu/Pr      =   0.614  --->  O.K !
          -. Muy/Mry    =   0.617  --->  O.K !
          -. Muz/Mrz    =   0.614  --->  O.K !
          -. Mu/Mr      =   0.617  --->  O.K !
          -. Ratio      =   0.617  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2524.95 kN.
          -. Vuz    =          9.72 kN.
          -. Muy    =       -903.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.39

          -. Vuy    =        184.36 kN.
          -. Muz    =      -2987.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.30
```

( ). Compute shear strength of concrete.
-. Vuz = 9.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1081.25 kN.
-. phiVcz = phi * Vcz = 973.12 kN.

-. Vuy = 184.36 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1037.88 kN.
-. phiVcy = phi * Vcy = 934.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2029.03 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6067.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2029.03 kN.
-. phiVsz = phi*Vsz = 1826.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1999.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6110.61 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1999.33 kN.
-. phiVsy = phi*Vsy = 1799.39 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 184.617 kN.
-. Vr = 2733.488 kN.
-. Ratio = Vu / Vr = 0.068 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 205.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 205.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0060 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0060 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0060 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115009,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            971.81       883.05       861.88      2911.35      2774.44
           ---------------------------------------------------------------------------
            DL+LL+Others      971.81       883.05       861.88      2911.35      2774.44
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      861.88 kN-m.
           -. End Moments (My2) =      883.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      883.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      883.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2774.44 kN-m.
          -. End Moments (Mz2) =     2911.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2911.35 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2911.35 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1638.214 kN.
          -. Mry        =      1477.109 kN-m.
          -. Mrz        =      4885.528 kN-m.
          -. Mr         =      5103.943 kN-m.
          -. Pu/Pr      =   0.593  --->  O.K !
          -. Muy/Mry    =   0.598  --->  O.K !
          -. Muz/Mrz    =   0.596  --->  O.K !
          -. Mu/Mr      =   0.598  --->  O.K !
          -. Ratio      =   0.598  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2541.62 kN.
          -. Vuz    =         46.65 kN.
          -. Muy    =       -902.28 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.70 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.39

          -. Vuy    =        281.15 kN.
          -. Muz    =      -2896.40 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.09 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.30
```

( ). Compute shear strength of concrete.
-. Vuz = 46.65 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1080.41 kN.
-. phiVcz = phi * Vcz = 972.37 kN.

-. Vuy = 281.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1037.05 kN.
-. phiVcy = phi * Vcy = 933.34 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2028.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6068.08 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2028.47 kN.
-. phiVsz = phi*Vsz = 1825.63 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1998.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6111.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1998.74 kN.
-. phiVsy = phi*Vsy = 1798.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 284.989 kN.
-. Vr = 2732.204 kN.
-. Ratio = Vu / Vr = 0.104 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 316.65 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 316.65 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0059 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0059 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0059 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115010,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            983.79       861.88       824.22      2774.44      2599.60
           ------------------------------------------------------------------------------
            DL+LL+Others      983.79       861.88       824.22      2774.44      2599.60
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      824.22 kN-m.
           -. End Moments (My2) =      861.88 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      861.88 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      861.88 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2599.60 kN-m.
          -. End Moments (Mz2) =     2774.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2774.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2774.44 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1712.847 kN.
          -. Mry        =      1512.774 kN-m.
          -. Mrz        =      4878.903 kN-m.
          -. Mr         =      5108.051 kN-m.
          -. Pu/Pr      =   0.574  --->  O.K !
          -. Muy/Mry    =   0.570  --->  O.K !
          -. Muz/Mrz    =   0.569  --->  O.K !
          -. Mu/Mr      =   0.574  --->  O.K !
          -. Ratio      =   0.574  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2558.29 kN.
          -. Vuz    =         78.42 kN.
          -. Muy    =       -881.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.41

          -. Vuy    =        359.42 kN.
          -. Muz    =      -2762.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.31
```

( ). Compute shear strength of concrete.
-. Vuz = 78.42 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1087.34 kN.
-. phiVcz = phi * Vcz = 978.61 kN.

-. Vuy = 359.42 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1043.97 kN.
-. phiVcy = phi * Vcy = 939.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2033.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6061.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2033.06 kN.
-. phiVsz = phi*Vsz = 1829.75 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2003.61 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6104.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2003.61 kN.
-. phiVsy = phi*Vsy = 1803.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 367.873 kN.
-. Vr = 2742.816 kN.
-. Ratio = Vu / Vr = 0.134 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 408.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 408.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0056 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0056 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115011,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            995.76       824.22       773.38      2599.60      2399.24
           ------------------------------------------------------------------------------
            DL+LL+Others      995.76       824.22       773.38      2599.60      2399.24
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      773.38 kN-m.
           -. End Moments (My2) =      824.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      824.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      824.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2399.24 kN-m.
          -. End Moments (Mz2) =     2599.60 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2599.60 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2599.60 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1859.676 kN.
          -. Mry        =      1545.337 kN-m.
          -. Mrz        =      4878.069 kN-m.
          -. Mr         =      5116.994 kN-m.
          -. Pu/Pr      =   0.535  --->  O.K !
          -. Muy/Mry    =   0.533  --->  O.K !
          -. Muz/Mrz    =   0.533  --->  O.K !
          -. Mu/Mr      =   0.535  --->  O.K !
          -. Ratio      =   0.535  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2574.96 kN.
          -. Vuz    =        103.94 kN.
          -. Muy    =       -843.47 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.44

          -. Vuy    =        417.93 kN.
          -. Muz    =      -2589.55 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.34
```

( ). Compute shear strength of concrete.
-. Vuz = 103.94 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1101.87 kN.
-. phiVcz = phi * Vcz = 991.69 kN.

-. Vuy = 417.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1058.49 kN.
-. phiVcy = phi * Vcy = 952.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2042.53 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6046.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2042.53 kN.
-. phiVsz = phi*Vsz = 1838.28 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2013.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6090.00 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2013.67 kN.
-. phiVsy = phi*Vsy = 1812.30 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 430.665 kN.
-. Vr = 2764.940 kN.
-. Ratio = Vu / Vr = 0.156 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 478.52 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 478.52 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115012,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1007.74       773.38       712.73      2399.24      2176.94
           ---------------------------------------------------------------------------
            DL+LL+Others     1007.74       773.38       712.73      2399.24      2176.94
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      712.73 kN-m.
           -. End Moments (My2) =      773.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      773.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      773.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2176.94 kN-m.
          -. End Moments (Mz2) =     2399.24 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2399.24 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2399.24 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2051.773 kN.
          -. Mry        =      1573.282 kN-m.
          -. Mrz        =      4881.627 kN-m.
          -. Mr         =      5128.889 kN-m.
          -. Pu/Pr      =   0.491  --->  O.K !
          -. Muy/Mry    =   0.492  --->  O.K !
          -. Muz/Mrz    =   0.491  --->  O.K !
          -. Mu/Mr      =   0.492  --->  O.K !
          -. Ratio      =   0.492  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2591.63 kN.
          -. Vuz    =        123.59 kN.
          -. Muy    =       -791.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.49

          -. Vuy    =        456.72 kN.
          -. Muz    =      -2391.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.71 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.39
```

( ). Compute shear strength of concrete.
-. Vuz = 123.59 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1122.94 kN.
-. phiVcz = phi * Vcz = 1010.65 kN.

-. Vuy = 456.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1079.56 kN.
-. phiVcy = phi * Vcy = 971.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2055.94 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6025.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2055.94 kN.
-. phiVsz = phi*Vsz = 1850.34 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2027.91 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6068.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2027.91 kN.
-. phiVsy = phi*Vsy = 1825.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 473.143 kN.
-. Vr = 2796.724 kN.
-. Ratio = Vu / Vr = 0.169 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 525.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 525.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115013,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1019.72       712.73       645.56      2176.94      1942.44
           ---------------------------------------------------------------------------
            DL+LL+Others    1019.72       712.73       645.56      2176.94      1942.44
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      645.56 kN-m.
           -. End Moments (My2) =      712.73 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      712.73 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      712.73 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1942.44 kN-m.
          -. End Moments (Mz2) =     2176.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2176.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2176.94 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2286.653 kN.
          -. Mry        =      1600.648 kN-m.
          -. Mrz        =      4888.430 kN-m.
          -. Mr         =      5143.814 kN-m.
          -. Pu/Pr      =   0.446  --->  O.K !
          -. Muy/Mry    =   0.445  --->  O.K !
          -. Muz/Mrz    =   0.445  --->  O.K !
          -. Mu/Mr      =   0.446  --->  O.K !
          -. Ratio      =   0.446  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2608.30 kN.
          -. Vuz    =        136.96 kN.
          -. Muy    =       -730.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.55

          -. Vuy    =        476.58 kN.
          -. Muz    =      -2170.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.47 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.45
```

( ). Compute shear strength of concrete.
-. Vuz = 136.96 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1150.59 kN.
-. phiVcz = phi * Vcz = 1035.53 kN.

-. Vuy = 476.58 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1107.28 kN.
-. phiVcy = phi * Vcy = 996.55 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2072.96 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5997.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2072.96 kN.
-. phiVsz = phi*Vsz = 1865.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2046.01 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6041.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2046.01 kN.
-. phiVsy = phi*Vsy = 1841.41 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 495.866 kN.
-. Vr = 2837.957 kN.
-. Ratio = Vu / Vr = 0.175 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 550.96 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 550.96 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115014,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1031.70       645.56       575.00      1942.44      1704.80
           ---------------------------------------------------------------------------
            DL+LL+Others    1031.70       645.56       575.00      1942.44      1704.80
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      575.00 kN-m.
           -. End Moments (My2) =      645.56 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      645.56 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      645.56 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1704.80 kN-m.
          -. End Moments (Mz2) =     1942.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1942.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1942.44 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2621.162 kN.
          -. Mry        =      1616.887 kN-m.
          -. Mrz        =      4899.917 kN-m.
          -. Mr         =      5159.797 kN-m.
          -. Pu/Pr      =   0.394  --->  O.K !
          -. Muy/Mry    =   0.399  --->  O.K !
          -. Muz/Mrz    =   0.396  --->  O.K !
          -. Mu/Mr      =   0.399  --->  O.K !
          -. Ratio      =   0.399  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2624.97 kN.
          -. Vuz    =        144.06 kN.
          -. Muy    =       -661.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62

          -. Vuy    =        478.91 kN.
          -. Muz    =      -1938.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.20 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53
```

( ). Compute shear strength of concrete.
-. Vuz = 144.06 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1184.07 kN.
-. phiVcz = phi * Vcz = 1065.66 kN.

-. Vuy = 478.91 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1140.90 kN.
-. phiVcy = phi * Vcy = 1026.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2092.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5964.42 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2092.75 kN.
-. phiVsz = phi*Vsz = 1883.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2067.07 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6007.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2067.07 kN.
-. phiVsy = phi*Vsy = 1860.36 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 500.103 kN.
-. Vr = 2887.174 kN.
-. Ratio = Vu / Vr = 0.173 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 555.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 555.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115015,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2641.64      -589.79      -517.16     -1701.95     -1470.62
           ------------------------------------------------------------------------------
            DL+LL+Others     2641.64      -589.79      -517.16     -1701.95     -1470.62
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      517.16 kN-m.
           -. End Moments (My2) =      589.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -589.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -589.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1470.62 kN-m.
          -. End Moments (Mz2) =     1701.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1701.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1701.95 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7506.862 kN.
          -. Mry        =      1668.794 kN-m.
          -. Mrz        =      4810.696 kN-m.
          -. Mr         =      5091.922 kN-m.
          -. Pu/Pr      =   0.352  --->  O.K !
          -. Muy/Mry    =   0.353  --->  O.K !
          -. Muz/Mrz    =   0.354  --->  O.K !
          -. Mu/Mr      =   0.354  --->  O.K !
          -. Ratio      =   0.354  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2641.64 kN.
          -. Vuz    =        145.28 kN.
          -. Muy    =       -589.79 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.61 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71

          -. Vuy    =        465.53 kN.
          -. Muz    =      -1701.95 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61
```

( ). Compute shear strength of concrete.
-. Vuz = 145.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1222.51 kN.
-. phiVcz = phi * Vcz = 1100.26 kN.

-. Vuy = 465.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1179.62 kN.
-. phiVcy = phi * Vcy = 1061.66 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2114.44 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5925.98 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2114.44 kN.
-. phiVsz = phi*Vsz = 1902.99 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2090.17 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5968.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2090.17 kN.
-. phiVsy = phi*Vsy = 1881.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 487.670 kN.
-. Vr = 2942.814 kN.
-. Ratio = Vu / Vr = 0.166 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 541.86 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 541.86 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115016,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2658.30      -517.16      -446.54     -1470.62     -1251.22
           ---------------------------------------------------------------------------
            DL+LL+Others     2658.30      -517.16      -446.54     -1470.62     -1251.22
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      446.54 kN-m.
           -. End Moments (My2) =      517.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -517.16 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -517.16 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1251.22 kN-m.
          -. End Moments (Mz2) =     1470.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1470.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1470.62 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8460.433 kN.
          -. Mry        =      1655.664 kN-m.
          -. Mrz        =      4700.845 kN-m.
          -. Mr         =      4983.891 kN-m.
          -. Pu/Pr      =   0.314  --->  O.K !
          -. Muy/Mry    =   0.312  --->  O.K !
          -. Muz/Mrz    =   0.313  --->  O.K !
          -. Mu/Mr      =   0.314  --->  O.K !
          -. Ratio      =   0.314  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2658.30 kN.
          -. Vuz    =        141.24 kN.
          -. Muy    =       -517.16 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =        439.70 kN.
          -. Muz    =      -1470.62 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 141.24 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1264.74 kN.
-. phiVcz = phi * Vcz = 1138.27 kN.

-. Vuy = 439.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1222.29 kN.
-. phiVcy = phi * Vcy = 1100.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2137.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5883.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2137.08 kN.
-. phiVsz = phi*Vsz = 1923.37 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2114.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5926.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2114.31 kN.
-. phiVsy = phi*Vsy = 1902.88 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 461.829 kN.
-. Vr = 3002.942 kN.
-. Ratio = Vu / Vr = 0.154 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 513.14 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 513.14 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115017,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2674.97      -446.54      -380.21     -1251.22     -1049.74
           ------------------------------------------------------------------------------
            DL+LL+Others     2674.97      -446.54      -380.21     -1251.22     -1049.74
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      380.21 kN-m.
           -. End Moments (My2) =      446.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -446.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -446.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1049.74 kN-m.
          -. End Moments (Mz2) =     1251.22 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1251.22 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1251.22 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9833.798 kN.
          -. Mry        =      1632.799 kN-m.
          -. Mrz        =      4565.528 kN-m.
          -. Mr         =      4848.719 kN-m.
          -. Pu/Pr      =   0.272  --->  O.K !
          -. Muy/Mry    =   0.273  --->  O.K !
          -. Muz/Mrz    =   0.274  --->  O.K !
          -. Mu/Mr      =   0.274  --->  O.K !
          -. Ratio      =   0.274  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2674.97 kN.
          -. Vuz    =        132.67 kN.
          -. Muy    =       -446.54 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90

          -. Vuy    =        403.15 kN.
          -. Muz    =      -1251.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.32 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.81
```

( ). Compute shear strength of concrete.
-. Vuz = 132.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1309.64 kN.
-. phiVcz = phi * Vcz = 1178.68 kN.

-. Vuy = 403.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1267.79 kN.
-. phiVcy = phi * Vcy = 1141.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2159.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5838.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2159.89 kN.
-. phiVsz = phi*Vsz = 1943.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2138.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5880.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2138.67 kN.
-. phiVsy = phi*Vsy = 1924.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 424.420 kN.
-. Vr = 3065.815 kN.
-. Ratio = Vu / Vr = 0.138 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 471.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 471.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                  Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115018,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2691.63      -380.21      -319.79     -1049.74      -870.08
           ------------------------------------------------------------------------------
            DL+LL+Others     2691.63      -380.21      -319.79     -1049.74      -870.08
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      319.79 kN-m.
           -. End Moments (My2) =      380.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -380.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -380.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      870.08 kN-m.
          -. End Moments (Mz2) =     1049.74 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1049.74 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1049.74 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11319.354 kN.
          -. Mry        =      1595.996 kN-m.
          -. Mrz        =      4433.414 kN-m.
          -. Mr         =      4711.939 kN-m.
          -. Pu/Pr      =   0.238  --->  O.K !
          -. Muy/Mry    =   0.238  --->  O.K !
          -. Muz/Mrz    =   0.237  --->  O.K !
          -. Mu/Mr      =   0.238  --->  O.K !
          -. Ratio      =   0.238  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2691.63 kN.
          -. Vuz    =        120.85 kN.
          -. Muy    =       -380.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =        359.45 kN.
          -. Muz    =      -1049.74 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 120.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1355.57 kN.
-. phiVcz = phi * Vcz = 1220.02 kN.

-. Vuy = 359.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1314.51 kN.
-. phiVcy = phi * Vcy = 1183.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2181.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5792.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2181.99 kN.
-. phiVsz = phi*Vsz = 1963.79 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2162.29 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5833.98 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2162.29 kN.
-. phiVsy = phi*Vsy = 1946.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 379.221 kN.
-. Vr = 3129.116 kN.
-. Ratio = Vu / Vr = 0.121 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 421.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 421.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-5.2912e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-4.5495e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-4.5495e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115019,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2708.30      -319.79      -264.82      -870.08      -709.27
           ------------------------------------------------------------------------------
            DL+LL+Others     2708.30      -319.79      -264.82      -870.08      -709.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      264.82 kN-m.
           -. End Moments (My2) =      319.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -319.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -319.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      709.27 kN-m.
          -. End Moments (Mz2) =      870.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -870.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -870.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     13127.211 kN.
          -. Mry        =      1561.896 kN-m.
          -. Mrz        =      4241.185 kN-m.
          -. Mr         =      4519.643 kN-m.
          -. Pu/Pr      =   0.206  --->  O.K !
          -. Muy/Mry    =   0.205  --->  O.K !
          -. Muz/Mrz    =   0.205  --->  O.K !
          -. Mu/Mr      =   0.206  --->  O.K !
          -. Ratio      =   0.206  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2708.30 kN.
          -. Vuz    =        109.94 kN.
          -. Muy    =       -319.79 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.57 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.10

          -. Vuy    =        321.71 kN.
          -. Muz    =       -870.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01
```

( ). Compute shear strength of concrete.
-. Vuz = 109.94 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1399.07 kN.
-. phiVcz = phi * Vcz = 1259.16 kN.

-. Vuy = 321.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1358.89 kN.
-. phiVcy = phi * Vcy = 1223.00 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2201.86 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5749.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2201.86 kN.
-. phiVsz = phi*Vsz = 1981.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2183.54 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5789.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2183.54 kN.
-. phiVsy = phi*Vsy = 1965.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 339.979 kN.
-. Vr = 3188.189 kN.
-. Ratio = Vu / Vr = 0.107 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 377.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 377.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115020,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2724.96      -264.82      -215.89      -709.27      -568.47
           ---------------------------------------------------------------------------
            DL+LL+Others     2724.96      -264.82      -215.89      -709.27      -568.47
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      215.89 kN-m.
           -. End Moments (My2) =      264.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -264.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -264.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      568.47 kN-m.
          -. End Moments (Mz2) =      709.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -709.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -709.27 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15364.533 kN.
          -. Mry        =      1476.394 kN-m.
          -. Mrz        =      3972.410 kN-m.
          -. Mr         =      4237.898 kN-m.
          -. Pu/Pr      =   0.177  --->  O.K !
          -. Muy/Mry    =   0.179  --->  O.K !
          -. Muz/Mrz    =   0.179  --->  O.K !
          -. Mu/Mr      =   0.179  --->  O.K !
          -. Ratio      =   0.179  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2724.96 kN.
          -. Vuz    =         97.87 kN.
          -. Muy    =       -264.82 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.35 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.19

          -. Vuy    =        281.67 kN.
          -. Muz    =       -709.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.55 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.10
```

( ). Compute shear strength of concrete.
-. Vuz = 97.87 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1441.61 kN.
-. phiVcz = phi * Vcz = 1297.45 kN.

-. Vuy = 281.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1402.43 kN.
-. phiVcy = phi * Vcy = 1262.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2220.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5706.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2220.36 kN.
-. phiVsz = phi*Vsz = 1998.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2203.35 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5746.06 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2203.35 kN.
-. phiVsy = phi*Vsy = 1983.02 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 298.188 kN.
-. Vr = 3245.207 kN.
-. Ratio = Vu / Vr = 0.092 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 331.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 331.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115021,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2741.63      -215.89      -173.30      -568.47      -448.06
           ------------------------------------------------------------------------------
            DL+LL+Others     2741.63      -215.89      -173.30      -568.47      -448.06
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      173.30 kN-m.
           -. End Moments (My2) =      215.89 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -215.89 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -215.89 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      448.06 kN-m.
          -. End Moments (Mz2) =      568.47 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -568.47 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -568.47 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17653.337 kN.
          -. Mry        =      1380.276 kN-m.
          -. Mrz        =      3622.891 kN-m.
          -. Mr         =      3876.919 kN-m.
          -. Pu/Pr      =   0.155  --->  O.K !
          -. Muy/Mry    =   0.156  --->  O.K !
          -. Muz/Mrz    =   0.157  --->  O.K !
          -. Mu/Mr      =   0.157  --->  O.K !
          -. Ratio      =   0.157  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2741.63 kN.
          -. Vuz    =         85.18 kN.
          -. Muy    =       -215.89 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.16 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.28

          -. Vuy    =        240.87 kN.
          -. Muz    =       -568.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.20
```

( ). Compute shear strength of concrete.
-. Vuz = 85.18 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1482.12 kN.
-. phiVcz = phi * Vcz = 1333.91 kN.

-. Vuy = 240.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1444.03 kN.
-. phiVcy = phi * Vcy = 1299.62 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2237.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5666.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2237.19 kN.
-. phiVsz = phi*Vsz = 2013.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2221.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5704.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2221.39 kN.
-. phiVsy = phi*Vsy = 1999.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 255.485 kN.
-. Vr = 3298.872 kN.
-. Ratio = Vu / Vr = 0.077 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 283.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 283.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115022,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2758.29      -173.30      -137.12      -448.06      -347.81
           ------------------------------------------------------------------------------
            DL+LL+Others     2758.29      -173.30      -137.12      -448.06      -347.81
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      137.12 kN-m.
           -. End Moments (My2) =      173.30 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -173.30 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -173.30 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      347.81 kN-m.
          -. End Moments (Mz2) =      448.06 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -448.06 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -448.06 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     19869.382 kN.
          -. Mry        =      1232.869 kN-m.
          -. Mrz        =      3207.733 kN-m.
          -. Mr         =      3436.498 kN-m.
          -. Pu/Pr      =   0.139  --->  O.K !
          -. Muy/Mry    =   0.141  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.141  --->  O.K !
          -. Ratio      =   0.141  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2758.29 kN.
          -. Vuz    =         72.36 kN.
          -. Muy    =       -173.30 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.99 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.36

          -. Vuy    =        200.56 kN.
          -. Muz    =       -448.06 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.28
```

( ). Compute shear strength of concrete.
-. Vuz = 72.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1519.63 kN.
-. phiVcz = phi * Vcz = 1367.67 kN.

-. Vuy = 200.56 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1482.66 kN.
-. phiVcy = phi * Vcy = 1334.39 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2252.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5628.86 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2252.12 kN.
-. phiVsz = phi*Vsz = 2026.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2237.41 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5665.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2237.41 kN.
-. phiVsy = phi*Vsy = 2013.67 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 213.213 kN.
-. Vr = 3348.058 kN.
-. Ratio = Vu / Vr = 0.064 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 236.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 236.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0025 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
==============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115023,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3413.77       -28.72       -22.46       -54.14       -42.17
           ---------------------------------------------------------------------------
            DL+LL+Others     3413.77       -28.72       -22.46       -54.14       -42.17
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       22.46 kN-m.
           -. End Moments (My2) =       28.72 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -22.46 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -22.46 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       42.17 kN-m.
          -. End Moments (Mz2) =       54.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -42.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -42.17 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       160.222 kN-m.
          -. Mrz        =       301.684 kN-m.
          -. Mr         =       341.591 kN-m.
          -. Pu/Pr      =   0.140  --->  O.K !
          -. Muy/Mry    =   0.140  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.140  --->  O.K !
          -. Ratio      =   0.140  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2774.95 kN.
          -. Vuz    =         63.40 kN.
          -. Muy    =       -137.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.43

          -. Vuy    =        172.87 kN.
          -. Muz    =       -347.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.35
```

( ). Compute shear strength of concrete.
-. Vuz = 63.40 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1550.75 kN.
-. phiVcz = phi * Vcz = 1395.68 kN.

-. Vuy = 172.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1514.79 kN.
-. phiVcy = phi * Vcy = 1363.31 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2264.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5597.74 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2264.07 kN.
-. phiVsz = phi*Vsz = 2037.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2250.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5633.70 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2250.23 kN.
-. phiVsy = phi*Vsy = 2025.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 184.127 kN.
-. Vr = 3388.516 kN.
-. Ratio = Vu / Vr = 0.054 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 204.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 204.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115024,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3430.43       -22.46       -16.90       -42.17       -31.90
           ---------------------------------------------------------------------------
            DL+LL+Others     3430.43       -22.46       -16.90       -42.17       -31.90
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       16.90 kN-m.
           -. End Moments (My2) =       22.46 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -16.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -16.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       31.90 kN-m.
          -. End Moments (Mz2) =       42.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -31.90 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -31.90 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       119.911 kN-m.
          -. Mrz        =       227.064 kN-m.
          -. Mr         =       256.781 kN-m.
          -. Pu/Pr      =   0.141  --->  O.K !
          -. Muy/Mry    =   0.141  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.141  --->  O.K !
          -. Ratio      =   0.141  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2791.61 kN.
          -. Vuz    =         55.68 kN.
          -. Muy    =       -105.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.75 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.49

          -. Vuy    =        149.41 kN.
          -. Muz    =       -261.44 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.42
```

( ). Compute shear strength of concrete.
-. Vuz = 55.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1578.30 kN.
-. phiVcz = phi * Vcz = 1420.47 kN.

-. Vuy = 149.41 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1543.29 kN.
-. phiVcy = phi * Vcy = 1388.96 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2274.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5570.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2274.33 kN.
-. phiVsz = phi*Vsz = 2046.89 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2261.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5605.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2261.24 kN.
-. phiVsy = phi*Vsy = 2035.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 159.450 kN.
-. Vr = 3424.081 kN.
-. Ratio = Vu / Vr = 0.047 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 177.17 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 177.17 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                  Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115025,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3447.09       -16.90       -11.96       -31.90       -23.11
           ------------------------------------------------------------------------------
            DL+LL+Others     3447.09       -16.90       -11.96       -31.90       -23.11
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       11.96 kN-m.
           -. End Moments (My2) =       16.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -11.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -11.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       23.11 kN-m.
          -. End Moments (Mz2) =       31.90 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -23.11 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -23.11 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        84.865 kN-m.
          -. Mrz        =       163.503 kN-m.
          -. Mr         =       184.215 kN-m.
          -. Pu/Pr      =   0.141  --->  O.K !
          -. Muy/Mry    =   0.141  --->  O.K !
          -. Muz/Mrz    =   0.141  --->  O.K !
          -. Mu/Mr      =   0.141  --->  O.K !
          -. Ratio      =   0.141  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2808.27 kN.
          -. Vuz    =         48.66 kN.
          -. Muy    =        -77.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.55

          -. Vuy    =        128.41 kN.
          -. Muz    =       -186.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.47
```

( ). Compute shear strength of concrete.
-. Vuz = 48.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1602.82 kN.
-. phiVcz = phi * Vcz = 1442.54 kN.

-. Vuy = 128.41 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1568.72 kN.
-. phiVcy = phi * Vcy = 1411.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2283.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5545.67 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2283.22 kN.
-. phiVsz = phi*Vsz = 2054.89 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2270.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5579.77 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2270.79 kN.
-. phiVsy = phi*Vsy = 2043.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 137.323 kN.
-. Vr = 3455.557 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 152.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 152.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115026,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3463.74       -11.96        -7.60       -23.11       -15.87
           ------------------------------------------------------------------------------
            DL+LL+Others     3463.74       -11.96        -7.60       -23.11       -15.87
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.60 kN-m.
           -. End Moments (My2) =       11.96 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.60 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.60 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       15.87 kN-m.
          -. End Moments (Mz2) =       23.11 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -15.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -15.87 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        53.566 kN-m.
          -. Mrz        =       111.823 kN-m.
          -. Mr         =       123.990 kN-m.
          -. Pu/Pr      =   0.142  --->  O.K !
          -. Muy/Mry    =   0.142  --->  O.K !
          -. Muz/Mrz    =   0.142  --->  O.K !
          -. Mu/Mr      =   0.142  --->  O.K !
          -. Ratio      =   0.142  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2824.94 kN.
          -. Vuz    =         42.47 kN.
          -. Muy    =        -53.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.60

          -. Vuy    =        110.17 kN.
          -. Muz    =       -123.03 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.52
```

( ). Compute shear strength of concrete.
-. Vuz = 42.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1624.31 kN.
-. phiVcz = phi * Vcz = 1461.88 kN.

-. Vuy = 110.17 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1591.03 kN.
-. phiVcy = phi * Vcy = 1431.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2290.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5524.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2290.82 kN.
-. phiVsz = phi*Vsz = 2061.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2278.97 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5557.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2278.97 kN.
-. phiVsy = phi*Vsy = 2051.07 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 118.077 kN.
-. Vr = 3483.005 kN.
-. Ratio = Vu / Vr = 0.034 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 131.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 131.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115027,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3480.40        -7.60        -4.20       -15.87       -10.01
           ---------------------------------------------------------------------------
            DL+LL+Others     3480.40        -7.60        -4.20       -15.87       -10.01
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.20 kN-m.
           -. End Moments (My2) =        7.60 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.20 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.20 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       10.01 kN-m.
          -. End Moments (Mz2) =       15.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -10.01 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -10.01 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        29.523 kN-m.
          -. Mrz        =        70.168 kN-m.
          -. Mr         =        76.126 kN-m.
          -. Pu/Pr      =   0.143  --->  O.K !
          -. Muy/Mry    =   0.142  --->  O.K !
          -. Muz/Mrz    =   0.143  --->  O.K !
          -. Mu/Mr      =   0.143  --->  O.K !
          -. Ratio      =   0.143  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2858.25 kN.
          -. Vuz    =         32.16 kN.
          -. Muy    =        -15.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =         80.35 kN.
          -. Muz    =        -28.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 32.16 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1644.75 kN.
-. phiVcz = phi * Vcz = 1480.28 kN.

-. Vuy = 80.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1612.30 kN.
-. phiVcy = phi * Vcy = 1451.07 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2297.91 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5503.73 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2297.91 kN.
-. phiVsz = phi*Vsz = 2068.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5536.19 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.59 kN.
-. phiVsy = phi*Vsy = 2057.93 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 86.549 kN.
-. Vr = 3509.003 kN.
-. Ratio = Vu / Vr = 0.025 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 96.17 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 96.17 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0043 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0043 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115028,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3497.05        -4.20        -1.98       -10.01        -5.78
           ---------------------------------------------------------------------------
            DL+LL+Others     3497.05        -4.20        -1.98       -10.01        -5.78
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.98 kN-m.
           -. End Moments (My2) =        4.20 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.98 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.98 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        5.78 kN-m.
          -. End Moments (Mz2) =       10.01 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -5.78 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -5.78 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =        13.818 kN-m.
           -. Mrz        =        40.350 kN-m.
           -. Mr         =        42.651 kN-m.
           -. Pu/Pr      =   0.143  --->  O.K !
           -. Muy/Mry    =   0.143  --->  O.K !
           -. Muz/Mrz    =   0.143  --->  O.K !
           -. Mu/Mr      =   0.143  --->  O.K !
           -. Ratio      =   0.143  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2874.91 kN.
           -. Vuz    =         19.67 kN.
           -. Muy    =         -6.12 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  30.42 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.68

           -. Vuy    =         45.25 kN.
           -. Muz    =         -7.87 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  30.54 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 19.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1661.31 kN.
-. phiVcz = phi * Vcz = 1495.18 kN.

-. Vuy = 45.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1629.54 kN.
-. phiVcy = phi * Vcy = 1466.59 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2303.55 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5487.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2303.55 kN.
-. phiVsz = phi*Vsz = 2073.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2292.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5518.94 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2292.65 kN.
-. phiVsy = phi*Vsy = 2063.39 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 49.338 kN.
-. Vr = 3529.976 kN.
-. Ratio = Vu / Vr = 0.014 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 54.82 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 54.82 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115029,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3513.71        -1.98        -0.77        -5.78        -3.60
           ------------------------------------------------------------------------------
            DL+LL+Others     3513.71        -1.98        -0.77        -5.78        -3.60
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.77 kN-m.
           -. End Moments (My2) =        1.98 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.60 kN-m.
          -. End Moments (Mz2) =        5.78 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.60 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.60 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         5.338 kN-m.
          -. Mrz        =        25.017 kN-m.
          -. Mr         =        25.580 kN-m.
          -. Pu/Pr      =   0.144  --->  O.K !
          -. Muy/Mry    =   0.144  --->  O.K !
          -. Muz/Mrz    =   0.144  --->  O.K !
          -. Mu/Mr      =   0.144  --->  O.K !
          -. Ratio      =   0.144  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3115.05 kN.
          -. Vuz    =         20.97 kN.
          -. Muy    =         -2.31 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =          9.71 kN.
          -. Muz    =         -4.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 20.97 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1644.38 kN.
-. phiVcz = phi * Vcz = 1479.94 kN.

-. Vuy = 9.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1611.91 kN.
-. phiVcy = phi * Vcy = 1450.72 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2297.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5504.11 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2297.78 kN.
-. phiVsz = phi*Vsz = 2068.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5536.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.45 kN.
-. phiVsy = phi*Vsy = 2057.81 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 23.106 kN.
-. Vr = 3508.527 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 25.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 25.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115030,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3530.36        -0.77        -0.38        -3.60        -2.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3530.36        -0.77        -0.38        -3.60        -2.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.38 kN-m.
           -. End Moments (My2) =        0.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        2.00 kN-m.
          -. End Moments (Mz2) =        3.60 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -2.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -2.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         2.631 kN-m.
          -. Mrz        =        13.835 kN-m.
          -. Mr         =        14.082 kN-m.
          -. Pu/Pr      =   0.145  --->  O.K !
          -. Muy/Mry    =   0.145  --->  O.K !
          -. Muz/Mrz    =   0.145  --->  O.K !
          -. Mu/Mr      =   0.145  --->  O.K !
          -. Ratio      =   0.145  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3131.71 kN.
          -. Vuz    =          7.22 kN.
          -. Muy    =         -1.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.47 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.65

          -. Vuy    =          2.84 kN.
          -. Muz    =         -3.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.58
```

( ). Compute shear strength of concrete.
-. Vuz = 7.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1649.94 kN.
-. phiVcz = phi * Vcz = 1484.95 kN.

-. Vuy = 2.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1617.70 kN.
-. phiVcy = phi * Vcy = 1455.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2299.69 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5498.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2299.69 kN.
-. phiVsz = phi*Vsz = 2069.72 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2288.50 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5530.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2288.50 kN.
-. phiVsy = phi*Vsy = 2059.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 7.760 kN.
-. Vr = 3515.580 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 8.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 8.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115031,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3547.02        -0.38        -0.12        -2.00        -0.63
           ------------------------------------------------------------------------------
            DL+LL+Others     3547.02        -0.38        -0.12        -2.00        -0.63
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.12 kN-m.
           -. End Moments (My2) =        0.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.63 kN-m.
          -. End Moments (Mz2) =        2.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.63 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.63 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.799 kN-m.
          -. Mrz        =         4.367 kN-m.
          -. Mr         =         4.439 kN-m.
          -. Pu/Pr      =   0.145  --->  O.K !
          -. Muy/Mry    =   0.145  --->  O.K !
          -. Muz/Mrz    =   0.145  --->  O.K !
          -. Mu/Mr      =   0.145  --->  O.K !
          -. Ratio      =   0.145  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2924.88 kN.
          -. Vuz    =          0.63 kN.
          -. Muy    =         -0.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.71

          -. Vuy    =          8.08 kN.
          -. Muz    =         -2.85 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.64
```

( ). Compute shear strength of concrete.
-. Vuz = 0.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1675.98 kN.
-. phiVcz = phi * Vcz = 1508.38 kN.

-. Vuy = 8.08 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1644.84 kN.
-. phiVcy = phi * Vcy = 1480.36 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2308.46 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5472.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2308.46 kN.
-. phiVsz = phi*Vsz = 2077.62 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2297.94 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5503.64 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2297.94 kN.
-. phiVsy = phi*Vsy = 2068.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 8.100 kN.
-. Vr = 3548.508 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 9.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 9.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0047 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115032,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3563.68        -0.12         0.00        -0.63         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3563.68        -0.12         0.00        -0.63         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.63 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.146  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.146  --->  O.K !
          -. Ratio      =   0.146  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2941.54 kN.
          -. Vuz    =          1.12 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =          5.70 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.64
```

( ). Compute shear strength of concrete.
-. Vuz = 1.12 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1643.84 kN.
-. phiVcz = phi * Vcz = 1479.45 kN.

-. Vuy = 5.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1643.84 kN.
-. phiVcy = phi * Vcy = 1479.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2297.60 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5504.65 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2297.60 kN.
-. phiVsz = phi*Vsz = 2067.84 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2297.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5504.65 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2297.60 kN.
-. phiVsy = phi*Vsy = 2067.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 5.812 kN.
-. Vr = 3547.290 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 6.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 6.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0047 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116102,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2128.47       567.70       363.55      2212.57      1473.21
           ---------------------------------------------------------------------------
           DL+LL+Others    -2128.47       567.70       363.55      2212.57      1473.21
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3673.756 kN.
          -. Mry        =       966.784 kN-m.
          -. Mrz        =      3816.373 kN-m.
          -. Mr         =      3936.924 kN-m.
          -. Pu/Pr      =   0.579  --->  O.K !
          -. Muy/Mry    =   0.587  --->  O.K !
          -. Muz/Mrz    =   0.580  --->  O.K !
          -. Mu/Mr      =   0.587  --->  O.K !
          -. Ratio      =   0.587  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5058.69 kN.
          -. Vuz    =        478.48 kN.
          -. Muy    =       -659.54 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  35.00 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.10
```

```
          -. Vuy    =       1451.58 kN.
          -. Muz    =      -1980.09 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.01

     ( ). Compute shear strength of concrete.
          -. Vuz       =      478.48 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      948.34 kN.
          -. phiVcz    = phi * Vcz =      853.50 kN.

          -. Vuy       =     1451.58 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      905.86 kN.
          -. phiVcy    = phi * Vcy =      815.28 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1931.71 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6200.15 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1931.71 kN.
          -. phiVsz   = phi*Vsz =     1738.54 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1896.25 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6242.62 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1896.25 kN.
          -. phiVsy   = phi*Vsy =     1706.62 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1528.404 kN.
          -. Vr       =    2521.899 kN.
          -. Ratio    = Vu / Vr = 0.606  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1698.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1698.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0013 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0013 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116103,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2116.69       363.55       355.55      1473.21       799.48
           ---------------------------------------------------------------------------
           DL+LL+Others    -2116.69       363.55       355.55      1473.21       799.48
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4933.197 kN.
          -. Mry        =       853.844 kN-m.
          -. Mrz        =      3429.044 kN-m.
          -. Mr         =      3533.751 kN-m.
          -. Pu/Pr      =   0.429  --->  O.K !
          -. Muy/Mry    =   0.426  --->  O.K !
          -. Muz/Mrz    =   0.430  --->  O.K !
          -. Mu/Mr      =   0.430  --->  O.K !
          -. Ratio      =   0.430  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5075.57 kN.
          -. Vuz    =        437.04 kN.
          -. Muy    =       -440.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.30
```

```
          -. Vuy    =       1327.26 kN.
          -. Muz    =      -1261.72 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.20

     ( ). Compute shear strength of concrete.
          -. Vuz       =      437.04 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1037.76 kN.
          -. phiVcz    = phi * Vcz =      933.99 kN.

          -. Vuy       =     1327.26 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      994.55 kN.
          -. phiVcy    = phi * Vcy =      895.09 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1999.24 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6110.72 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1999.24 kN.
          -. phiVsz   = phi*Vsz =     1799.32 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1967.73 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6153.94 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1967.73 kN.
          -. phiVsy   = phi*Vsy =     1770.96 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1397.367 kN.
          -. Vr       =    2666.051 kN.
          -. Ratio    = Vu / Vr = 0.524  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1552.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1552.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0013 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0013 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116104,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2104.92       355.55       415.07       799.48       210.89
           ---------------------------------------------------------------------------
           DL+LL+Others    -2104.92       355.55       415.07       799.48       210.89
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6879.677 kN.
          -. Mry        =      1163.118 kN-m.
          -. Mrz        =      2606.789 kN-m.
          -. Mr         =      2854.503 kN-m.
          -. Pu/Pr      =   0.306  --->  O.K !
          -. Muy/Mry    =   0.306  --->  O.K !
          -. Muz/Mrz    =   0.307  --->  O.K !
          -. Mu/Mr      =   0.307  --->  O.K !
          -. Ratio      =   0.307  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5109.09 kN.
          -. Vuz    =        395.33 kN.
          -. Muy    =       -464.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.39
```

```
          -. Vuy    =       1201.86 kN.
          -. Muz    =        -41.34 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.29

     ( ). Compute shear strength of concrete.
          -. Vuz       =      395.33 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1078.49 kN.
          -. phiVcz    = phi * Vcz =      970.64 kN.

          -. Vuy       =     1201.86 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1035.13 kN.
          -. phiVcy    = phi * Vcy =      931.62 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2027.20 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6069.99 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2027.20 kN.
          -. phiVsz   = phi*Vsz =     1824.48 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1997.38 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6113.36 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1997.38 kN.
          -. phiVsy   = phi*Vsy =     1797.64 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1265.208 kN.
          -. Vr       =    2729.261 kN.
          -. Ratio    = Vu / Vr = 0.464  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1405.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1405.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116105,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2081.14       415.07       485.48       210.89       654.21
           ---------------------------------------------------------------------------
           DL+LL+Others    -2081.14       415.07       485.48       210.89       654.21
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7087.182 kN.
          -. Mry        =      1658.930 kN-m.
          -. Mrz        =      2228.074 kN-m.
          -. Mr         =      2777.834 kN-m.
          -. Pu/Pr      =   0.294  --->  O.K !
          -. Muy/Mry    =   0.293  --->  O.K !
          -. Muz/Mrz    =   0.294  --->  O.K !
          -. Mu/Mr      =   0.294  --->  O.K !
          -. Ratio      =   0.294  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5125.96 kN.
          -. Vuz    =        353.83 kN.
          -. Muy    =       -522.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.45
```

```
          -. Vuy    =       1076.84 kN.
          -. Muz    =       -505.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.35

     ( ). Compute shear strength of concrete.
          -. Vuz       =      353.83 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1106.38 kN.
          -. phiVcz    = phi * Vcz =      995.75 kN.

          -. Vuy       =     1076.84 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1062.99 kN.
          -. phiVcy    = phi * Vcy =      956.70 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2045.44 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6042.10 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2045.44 kN.
          -. phiVsz   = phi*Vsz =     1840.89 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2016.75 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6085.49 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2016.75 kN.
          -. phiVsy   = phi*Vsy =     1815.08 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1133.484 kN.
          -. Vr       =    2771.770 kN.
          -. Ratio    = Vu / Vr = 0.409  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1259.43 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1259.43 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116106,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2069.35       485.48       564.06       654.21      1111.35
           ---------------------------------------------------------------------------
           DL+LL+Others    -2069.35       485.48       564.06       654.21      1111.35
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5542.819 kN.
          -. Mry        =      1517.017 kN-m.
          -. Mrz        =      2964.227 kN-m.
          -. Mr         =      3329.862 kN-m.
          -. Pu/Pr      =   0.373  --->  O.K !
          -. Muy/Mry    =   0.372  --->  O.K !
          -. Muz/Mrz    =   0.375  --->  O.K !
          -. Mu/Mr      =   0.375  --->  O.K !
          -. Ratio      =   0.375  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5142.81 kN.
          -. Vuz    =        313.08 kN.
          -. Muy    =       -589.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.43
```

```
          -. Vuy    =       953.70 kN.
          -. Muz    =      -982.67 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.34

     ( ). Compute shear strength of concrete.
          -. Vuz       =     313.08 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1098.39 kN.
          -. phiVcz    = phi * Vcz =      988.55 kN.

          -. Vuy       =     953.70 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1055.00 kN.
          -. phiVcy    = phi * Vcy =      949.50 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2040.28 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6050.10 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2040.28 kN.
          -. phiVsz   = phi*Vsz =     1836.25 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2011.27 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6093.49 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2011.27 kN.
          -. phiVsy   = phi*Vsy =     1810.14 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1003.775 kN.
          -. Vr       =    2759.643 kN.
          -. Ratio    = Vu / Vr = 0.364  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1115.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1115.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116107,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2057.55       564.06       645.08      1111.35      1515.20
           ---------------------------------------------------------------------------
           DL+LL+Others    -2057.55       564.06       645.08      1111.35      1515.20
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4545.694 kN.
          -. Mry        =      1433.712 kN-m.
          -. Mrz        =      3367.314 kN-m.
          -. Mr         =      3659.827 kN-m.
          -. Pu/Pr      =   0.453  --->  O.K !
          -. Muy/Mry    =   0.450  --->  O.K !
          -. Muz/Mrz    =   0.450  --->  O.K !
          -. Mu/Mr      =   0.453  --->  O.K !
          -. Ratio      =   0.453  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5159.66 kN.
          -. Vuz    =        273.59 kN.
          -. Muy    =       -660.27 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

-. Vuy = 833.98 kN.
-. Muz = -1406.21 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.28 Deg. [Clause 5.8.3.4.2]
-. betay = 2.25

( ). Compute shear strength of concrete.
-. Vuz = 273.59 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1060.60 kN.
-. phiVcz = phi * Vcz = 954.54 kN.

-. Vuy = 833.98 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1017.29 kN.
-. phiVcy = phi * Vcy = 915.56 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2015.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6087.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2015.12 kN.
-. phiVsz = phi*Vsz = 1813.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1984.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6131.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1984.57 kN.
-. phiVsy = phi*Vsy = 1786.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 877.705 kN.
-. Vr = 2701.671 kN.
-. Ratio = Vu / Vr = 0.325 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 975.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 975.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116108,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2045.74       645.08       721.18      1515.20      1864.57
           ---------------------------------------------------------------------------
           DL+LL+Others    -2045.74       645.08       721.18      1515.20      1864.57
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3928.107 kN.
          -. Mry        =      1406.482 kN-m.
          -. Mrz        =      3593.353 kN-m.
          -. Mr         =      3858.805 kN-m.
          -. Pu/Pr      =   0.521  --->  O.K !
          -. Muy/Mry    =   0.513  --->  O.K !
          -. Muz/Mrz    =   0.519  --->  O.K !
          -. Mu/Mr      =   0.521  --->  O.K !
          -. Ratio      =   0.521  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5176.50 kN.
          -. Vuz    =        235.88 kN.
          -. Muy    =       -726.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.16 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =       719.22 kN.
          -. Muz    =     -1774.61 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.18

     ( ). Compute shear strength of concrete.
          -. Vuz       =     235.88 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1029.67 kN.
          -. phiVcz    = phi * Vcz =      926.70 kN.

          -. Vuy       =     719.22 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      986.50 kN.
          -. phiVcy    = phi * Vcy =      887.85 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1993.49 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6118.81 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1993.49 kN.
          -. phiVsz   = phi*Vsz =     1794.14 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1961.64 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6161.99 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1961.64 kN.
          -. phiVsy   = phi*Vsy =     1765.47 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     756.913 kN.
          -. Vr       =    2653.321 kN.
          -. Ratio    = Vu / Vr = 0.285  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 841.01 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 841.01 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116109,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2033.93       721.18       792.47      1864.57      2152.58
           ---------------------------------------------------------------------------
           DL+LL+Others    -2033.93       721.18       792.47      1864.57      2152.58
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3535.041 kN.
          -. Mry        =      1378.943 kN-m.
          -. Mrz        =      3729.394 kN-m.
          -. Mr         =      3976.162 kN-m.
          -. Pu/Pr      =   0.575  --->  O.K !
          -. Muy/Mry    =   0.575  --->  O.K !
          -. Muz/Mrz    =   0.577  --->  O.K !
          -. Mu/Mr      =   0.577  --->  O.K !
          -. Ratio      =   0.577  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5193.34 kN.
          -. Vuz    =        194.73 kN.
          -. Muy    =       -789.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

-. Vuy = 593.54 kN.
-. Muz = -2080.77 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.83 Deg. [Clause 5.8.3.4.2]
-. betay = 2.13

( ). Compute shear strength of concrete.
-. Vuz = 194.73 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1007.57 kN.
-. phiVcz = phi * Vcz = 906.82 kN.

-. Vuy = 593.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 964.54 kN.
-. phiVcy = phi * Vcy = 868.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1977.44 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6140.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1977.44 kN.
-. phiVsz = phi*Vsz = 1779.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1944.63 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6183.95 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1944.63 kN.
-. phiVsy = phi*Vsy = 1750.17 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 624.666 kN.
-. Vr = 2618.254 kN.
-. Ratio = Vu / Vr = 0.239 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 694.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 694.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116110,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2022.11       792.47       842.58      2152.58      2345.88
           ---------------------------------------------------------------------------
           DL+LL+Others    -2022.11       792.47       842.58      2152.58      2345.88
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3287.521 kN.
          -. Mry        =      1370.843 kN-m.
          -. Mrz        =      3811.267 kN-m.
          -. Mr         =      4050.305 kN-m.
          -. Pu/Pr      =   0.615  --->  O.K !
          -. Muy/Mry    =   0.615  --->  O.K !
          -. Muz/Mrz    =   0.616  --->  O.K !
          -. Mu/Mr      =   0.616  --->  O.K !
          -. Ratio      =   0.616  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5210.17 kN.
          -. Vuz    =        132.64 kN.
          -. Muy    =       -831.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.22
```

```
          -. Vuy    =       402.34 kN.
          -. Muz    =     -2290.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.88 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.12

     ( ). Compute shear strength of concrete.
          -. Vuz       =     132.64 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1002.72 kN.
          -. phiVcz    = phi * Vcz =      902.45 kN.

          -. Vuy       =     402.34 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      959.73 kN.
          -. phiVcy    = phi * Vcy =      863.75 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1973.85 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6145.76 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1973.85 kN.
          -. phiVsz   = phi*Vsz =     1776.46 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1940.82 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6188.76 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1940.82 kN.
          -. phiVsy   = phi*Vsy =     1746.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     423.639 kN.
          -. Vr       =    2610.495 kN.
          -. Ratio    = Vu / Vr = 0.162  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 470.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 470.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-4.2267e-006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =9.6611e-006 m^2.
-. As_req = MAX[Asy_req, Asz_req] =9.6611e-006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116111,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2010.28       842.58       866.62      2345.88      2451.93
           ---------------------------------------------------------------------------
           DL+LL+Others    -2010.28       842.58       866.62      2345.88      2451.93
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3179.952 kN.
          -. Mry        =      1360.965 kN-m.
          -. Mrz        =      3848.873 kN-m.
          -. Mr         =      4082.408 kN-m.
          -. Pu/Pr      =   0.632  --->  O.K !
          -. Muy/Mry    =   0.637  --->  O.K !
          -. Muz/Mrz    =   0.637  --->  O.K !
          -. Mu/Mr      =   0.637  --->  O.K !
          -. Ratio      =   0.637  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5226.99 kN.
          -. Vuz    =         77.31 kN.
          -. Muy    =       -850.29 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

```
          -. Vuy    =       227.53 kN.
          -. Muz    =     -2411.54 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.13

     ( ). Compute shear strength of concrete.
          -. Vuz       =       77.31 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1006.05 kN.
          -. phiVcz    = phi * Vcz =      905.45 kN.

          -. Vuy       =      227.53 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      963.03 kN.
          -. phiVcy    = phi * Vcy =      866.73 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1976.32 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6142.43 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1976.32 kN.
          -. phiVsz   = phi*Vsz =     1778.69 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1943.44 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6185.46 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1943.44 kN.
          -. phiVsy   = phi*Vsy =     1749.10 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     240.304 kN.
          -. Vr       =    2615.823 kN.
          -. Ratio    = Vu / Vr = 0.092  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 267.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 267.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-1.0820e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-2.9767e-006 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-2.9767e-006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116112,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1998.45       866.62       867.18      2451.93      2480.22
           ---------------------------------------------------------------------------
           DL+LL+Others    -1998.45       866.62       867.18      2451.93      2480.22
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3108.869 kN.
          -. Mry        =      1354.355 kN-m.
          -. Mrz        =      3873.686 kN-m.
          -. Mr         =      4103.623 kN-m.
          -. Pu/Pr      =   0.643  --->  O.K !
          -. Muy/Mry    =   0.640  --->  O.K !
          -. Muz/Mrz    =   0.640  --->  O.K !
          -. Mu/Mr      =   0.643  --->  O.K !
          -. Ratio      =   0.643  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5243.80 kN.
          -. Vuz    =         58.64 kN.
          -. Muy    =       -846.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.30 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

-. Vuy = 73.03 kN.
-. Muz = -2452.88 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.75 Deg. [Clause 5.8.3.4.2]
-. betay = 2.15

( ). Compute shear strength of concrete.
-. Vuz = 58.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1014.89 kN.
-. phiVcz = phi * Vcz = 913.40 kN.

-. Vuy = 73.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 971.81 kN.
-. phiVcy = phi * Vcy = 874.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1982.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6133.59 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1982.82 kN.
-. phiVsz = phi*Vsz = 1784.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1950.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6176.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1950.32 kN.
-. phiVsy = phi*Vsy = 1755.29 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 93.658 kN.
-. Vr = 2629.919 kN.
-. Ratio = Vu / Vr = 0.036 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 104.06 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 104.06 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116113,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1998.60       867.18       847.68      2480.22      2441.59
           ---------------------------------------------------------------------------
           DL+LL+Others    -1998.60       867.18       847.68      2480.22      2441.59
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3108.869 kN.
          -. Mry        =      1354.355 kN-m.
          -. Mrz        =      3873.686 kN-m.
          -. Mr         =      4103.623 kN-m.
          -. Pu/Pr      =   0.643  --->  O.K !
          -. Muy/Mry    =   0.640  --->  O.K !
          -. Muz/Mrz    =   0.640  --->  O.K !
          -. Mu/Mr      =   0.643  --->  O.K !
          -. Ratio      =   0.643  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3685.24 kN.
          -. Vuz    =        143.49 kN.
          -. Muy    =      -1912.83 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.52
```

```
          -. Vuy    =         36.40 kN.
          -. Muz    =      -1130.06 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.42

     ( ). Compute shear strength of concrete.
          -. Vuz       =      143.49 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1137.28 kN.
          -. phiVcz    = phi * Vcz =     1023.55 kN.

          -. Vuy       =       36.40 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1093.93 kN.
          -. phiVcy    = phi * Vcy =      984.53 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2064.84 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6011.21 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2064.84 kN.
          -. phiVsz   = phi*Vsz =     1858.36 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2037.38 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6054.56 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2037.38 kN.
          -. phiVsy   = phi*Vsy =     1833.64 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     148.034 kN.
          -. Vr       =    2818.173 kN.
          -. Ratio    = Vu / Vr = 0.053  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 164.48 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 164.48 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0013 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0013 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0013 m^2.
- As = 0.0363 m^2.
- As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116114,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1986.75       847.68       810.61      2441.59      2347.63
           ---------------------------------------------------------------------------
           DL+LL+Others    -1986.75       847.68       810.61      2441.59      2347.63
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3143.617 kN.
          -. Mry        =      1342.634 kN-m.
          -. Mrz        =      3866.615 kN-m.
          -. Mr         =      4093.089 kN-m.
          -. Pu/Pr      =   0.632  --->  O.K !
          -. Muy/Mry    =   0.631  --->  O.K !
          -. Muz/Mrz    =   0.631  --->  O.K !
          -. Mu/Mr      =   0.632  --->  O.K !
          -. Ratio      =   0.632  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3701.97 kN.
          -. Vuz    =        206.04 kN.
          -. Muy    =      -1849.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51
```

-. Vuy = 81.11 kN.
-. Muz = -1118.41 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.60 Deg. [Clause 5.8.3.4.2]
-. betay = 2.42

( ). Compute shear strength of concrete.
-. Vuz = 206.04 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1135.87 kN.
-. phiVcz = phi * Vcz = 1022.28 kN.

-. Vuy = 81.11 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1092.51 kN.
-. phiVcy = phi * Vcy = 983.26 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2063.97 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6012.62 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2063.97 kN.
-. phiVsz = phi*Vsz = 1857.58 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2036.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6055.97 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2036.45 kN.
-. phiVsy = phi*Vsy = 1832.81 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 221.431 kN.
-. Vr = 2816.068 kN.
-. Ratio = Vu / Vr = 0.079 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 246.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 246.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116115,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1974.90       810.61       759.80      2347.63      2210.83
           ---------------------------------------------------------------------------
           DL+LL+Others    -1974.90       810.61       759.80      2347.63      2210.83
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3249.335 kN.
          -. Mry        =      1326.286 kN-m.
          -. Mrz        =      3838.535 kN-m.
          -. Mr         =      4061.205 kN-m.
          -. Pu/Pr      =   0.608  --->  O.K !
          -. Muy/Mry    =   0.611  --->  O.K !
          -. Muz/Mrz    =   0.612  --->  O.K !
          -. Mu/Mr      =   0.612  --->  O.K !
          -. Ratio      =   0.612  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5277.55 kN.
          -. Vuz    =        110.79 kN.
          -. Muy    =       -785.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.36 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

```
          -. Vuy    =       260.74 kN.
          -. Muz    =     -2340.85 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.14

     ( ). Compute shear strength of concrete.
          -. Vuz       =     110.79 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1009.17 kN.
          -. phiVcz    = phi * Vcz =      908.25 kN.

          -. Vuy       =     260.74 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      966.13 kN.
          -. phiVcy    = phi * Vcy =      869.51 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1978.62 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6139.32 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1978.62 kN.
          -. phiVsz   = phi*Vsz =     1780.76 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1945.88 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6182.36 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1945.88 kN.
          -. phiVsy   = phi*Vsy =     1751.29 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     283.298 kN.
          -. Vr       =    2620.804 kN.
          -. Ratio    = Vu / Vr = 0.108  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 314.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 314.78 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116116,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1963.04       759.80       699.05      2210.83      2042.40
           ---------------------------------------------------------------------------
           DL+LL+Others    -1963.04       759.80       699.05      2210.83      2042.40
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3403.560 kN.
          -. Mry        =      1306.373 kN-m.
          -. Mrz        =      3796.134 kN-m.
          -. Mr         =      4014.629 kN-m.
          -. Pu/Pr      =   0.577  --->  O.K !
          -. Muy/Mry    =   0.582  --->  O.K !
          -. Muz/Mrz    =   0.582  --->  O.K !
          -. Mu/Mr      =   0.582  --->  O.K !
          -. Ratio      =   0.582  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5294.33 kN.
          -. Vuz    =        124.83 kN.
          -. Muy    =       -733.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.28 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

```
          -. Vuy    =       327.42 kN.
          -. Muz    =     -2211.65 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.16

     ( ). Compute shear strength of concrete.
          -. Vuz       =     124.83 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1017.19 kN.
          -. phiVcz    = phi * Vcz =      915.47 kN.

          -. Vuy       =     327.42 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      974.09 kN.
          -. phiVcy    = phi * Vcy =      876.68 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1984.49 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6131.30 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1984.49 kN.
          -. phiVsz   = phi*Vsz =     1786.04 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1952.10 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6174.40 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1952.10 kN.
          -. phiVsy   = phi*Vsy =     1756.89 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     350.410 kN.
          -. Vr       =    2633.566 kN.
          -. Ratio    = Vu / Vr = 0.133  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 389.34 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 389.34 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116117,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1951.17       699.05       632.05      2042.40      1853.06
           ---------------------------------------------------------------------------
           DL+LL+Others    -1951.17       699.05       632.05      2042.40      1853.06
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3571.632 kN.
          -. Mry        =      1285.892 kN-m.
          -. Mrz        =      3749.374 kN-m.
          -. Mr         =      3963.752 kN-m.
          -. Pu/Pr      =   0.546  --->  O.K !
          -. Muy/Mry    =   0.544  --->  O.K !
          -. Muz/Mrz    =   0.545  --->  O.K !
          -. Mu/Mr      =   0.546  --->  O.K !
          -. Ratio      =   0.546  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5311.11 kN.
          -. Vuz    =        134.42 kN.
          -. Muy    =       -673.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

-. Vuy = 371.65 kN.
-. Muz = -2049.13 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.57 Deg. [Clause 5.8.3.4.2]
-. betay = 2.19

( ). Compute shear strength of concrete.
-. Vuz = 134.42 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1031.36 kN.
-. phiVcz = phi * Vcz = 928.23 kN.

-. Vuy = 371.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 988.18 kN.
-. phiVcy = phi * Vcy = 889.36 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1994.70 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6117.12 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1994.70 kN.
-. phiVsz = phi*Vsz = 1795.23 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1962.92 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6160.31 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1962.92 kN.
-. phiVsy = phi*Vsy = 1766.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 395.207 kN.
-. Vr = 2655.984 kN.
-. Ratio = Vu / Vr = 0.149 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 439.12 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 439.12 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116118,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1939.30       632.05       562.21      1853.06      1653.23
           ---------------------------------------------------------------------------
           DL+LL+Others    -1939.30       632.05       562.21      1853.06      1653.23
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3828.198 kN.
          -. Mry        =      1257.873 kN-m.
          -. Mrz        =      3676.652 kN-m.
          -. Mr         =      3885.874 kN-m.
          -. Pu/Pr      =   0.507  --->  O.K !
          -. Muy/Mry    =   0.502  --->  O.K !
          -. Muz/Mrz    =   0.504  --->  O.K !
          -. Mu/Mr      =   0.507  --->  O.K !
          -. Ratio      =   0.507  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5327.89 kN.
          -. Vuz    =        138.03 kN.
          -. Muy    =       -607.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.96 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.33
```

-. Vuy = 394.89 kN.
-. Muz = -1864.14 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.38 Deg. [Clause 5.8.3.4.2]
-. betay = 2.23

( ). Compute shear strength of concrete.
-. Vuz = 138.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1050.81 kN.
-. phiVcz = phi * Vcz = 945.73 kN.

-. Vuy = 394.89 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1007.53 kN.
-. phiVcy = phi * Vcy = 906.78 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2008.38 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6097.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2008.38 kN.
-. phiVsz = phi*Vsz = 1807.54 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1977.41 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6140.95 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1977.41 kN.
-. phiVsy = phi*Vsy = 1779.67 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 418.318 kN.
-. Vr = 2686.453 kN.
-. Ratio = Vu / Vr = 0.156 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 464.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 464.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116119,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1927.41       562.21       492.61      1653.23      1452.39
           ---------------------------------------------------------------------------
           DL+LL+Others    -1927.41       562.21       492.61      1653.23      1452.39
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4178.986 kN.
          -. Mry        =      1221.567 kN-m.
          -. Mrz        =      3576.114 kN-m.
          -. Mr         =      3778.997 kN-m.
          -. Pu/Pr      =   0.461  --->  O.K !
          -. Muy/Mry    =   0.460  --->  O.K !
          -. Muz/Mrz    =   0.462  --->  O.K !
          -. Mu/Mr      =   0.462  --->  O.K !
          -. Ratio      =   0.462  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5344.65 kN.
          -. Vuz    =        136.27 kN.
          -. Muy    =       -538.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.75 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.38
```

```
          -. Vuy    =       399.16 kN.
          -. Muz    =     -1667.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.28

     ( ). Compute shear strength of concrete.
          -. Vuz       =     136.27 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1074.55 kN.
          -. phiVcz    = phi * Vcz =      967.10 kN.

          -. Vuy       =     399.16 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1031.20 kN.
          -. phiVcy    = phi * Vcy =      928.08 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2024.56 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6073.94 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2024.56 kN.
          -. phiVsz   = phi*Vsz =     1822.10 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1994.58 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6117.29 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1994.58 kN.
          -. phiVsy   = phi*Vsy =     1795.13 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     421.776 kN.
          -. Vr       =    2723.206 kN.
          -. Ratio    = Vu / Vr = 0.155  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 468.64 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 468.64 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116120,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1915.53       492.61       425.83      1452.39      1258.53
           ---------------------------------------------------------------------------
           DL+LL+Others    -1915.53       492.61       425.83      1452.39      1258.53
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4540.404 kN.
          -. Mry        =      1184.558 kN-m.
          -. Mrz        =      3471.952 kN-m.
          -. Mr         =      3668.464 kN-m.
          -. Pu/Pr      =   0.422  --->  O.K !
          -. Muy/Mry    =   0.416  --->  O.K !
          -. Muz/Mrz    =   0.418  --->  O.K !
          -. Mu/Mr      =   0.422  --->  O.K !
          -. Ratio      =   0.422  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5361.41 kN.
          -. Vuz    =        129.90 kN.
          -. Muy    =       -471.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.44
```

-. Vuy = 387.31 kN.
-. Muz = -1468.01 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.90 Deg. [Clause 5.8.3.4.2]
-. betay = 2.34

( ). Compute shear strength of concrete.
-. Vuz = 129.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1101.50 kN.
-. phiVcz = phi * Vcz = 991.35 kN.

-. Vuy = 387.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1058.11 kN.
-. phiVcy = phi * Vcy = 952.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2042.29 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6046.99 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2042.29 kN.
-. phiVsz = phi*Vsz = 1838.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2013.41 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6090.38 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2013.41 kN.
-. phiVsy = phi*Vsy = 1812.07 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 408.511 kN.
-. Vr = 2764.369 kN.
-. Ratio = Vu / Vr = 0.148 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 453.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 453.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116121,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1903.63       425.83       362.77      1258.53      1074.72
           ---------------------------------------------------------------------------
           DL+LL+Others    -1903.63       425.83       362.77      1258.53      1074.72
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5054.895 kN.
          -. Mry        =      1118.284 kN-m.
          -. Mrz        =      3317.509 kN-m.
          -. Mr         =      3500.918 kN-m.
          -. Pu/Pr      =   0.377  --->  O.K !
          -. Muy/Mry    =   0.381  --->  O.K !
          -. Muz/Mrz    =   0.379  --->  O.K !
          -. Mu/Mr      =   0.381  --->  O.K !
          -. Ratio      =   0.381  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5378.17 kN.
          -. Vuz    =        122.17 kN.
          -. Muy    =       -406.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.50
```

-. Vuy = 368.59 kN.
-. Muz = -1274.71 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.65 Deg. [Clause 5.8.3.4.2]
-. betay = 2.40

( ). Compute shear strength of concrete.
-. Vuz = 122.17 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1129.76 kN.
-. phiVcz = phi * Vcz = 1016.78 kN.

-. Vuy = 368.59 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1086.39 kN.
-. phiVcy = phi * Vcy = 977.75 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2060.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6018.73 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2060.19 kN.
-. phiVsz = phi*Vsz = 1854.17 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2032.43 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6062.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2032.43 kN.
-. phiVsy = phi*Vsy = 1829.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 388.310 kN.
-. Vr = 2806.937 kN.
-. Ratio = Vu / Vr = 0.138 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 431.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 431.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116122,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1891.73       362.77       304.57      1074.72       904.32
           ---------------------------------------------------------------------------
           DL+LL+Others    -1891.73       362.77       304.57      1074.72       904.32
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5532.339 kN.
          -. Mry        =      1064.235 kN-m.
          -. Mrz        =      3158.529 kN-m.
          -. Mr         =      3333.002 kN-m.
          -. Pu/Pr      =   0.342  --->  O.K !
          -. Muy/Mry    =   0.341  --->  O.K !
          -. Muz/Mrz    =   0.340  --->  O.K !
          -. Mu/Mr      =   0.342  --->  O.K !
          -. Ratio      =   0.342  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5394.91 kN.
          -. Vuz    =        112.35 kN.
          -. Muy    =       -345.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.57
```

```
          -. Vuy    =       342.62 kN.
          -. Muz    =     -1090.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.40 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.47

     ( ). Compute shear strength of concrete.
          -. Vuz       =     112.35 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1158.99 kN.
          -. phiVcz    = phi * Vcz =     1043.09 kN.

          -. Vuy       =     342.62 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1115.70 kN.
          -. phiVcy    = phi * Vcy =     1004.13 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2078.00 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5989.50 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2078.00 kN.
          -. phiVsz   = phi*Vsz =     1870.20 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2051.38 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6032.78 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2051.38 kN.
          -. phiVsy   = phi*Vsy =     1846.24 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     360.574 kN.
          -. Vr       =    2850.372 kN.
          -. Ratio    = Vu / Vr = 0.127  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 400.64 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 400.64 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116123,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1879.82       304.57       252.00       904.32       749.78
           ---------------------------------------------------------------------------
           DL+LL+Others    -1879.82       304.57       252.00       904.32       749.78
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6147.396 kN.
          -. Mry        =       995.047 kN-m.
          -. Mrz        =      2951.870 kN-m.
          -. Mr         =      3115.069 kN-m.
          -. Pu/Pr      =   0.306  --->  O.K !
          -. Muy/Mry    =   0.306  --->  O.K !
          -. Muz/Mrz    =   0.306  --->  O.K !
          -. Mu/Mr      =   0.306  --->  O.K !
          -. Ratio      =   0.306  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5411.65 kN.
          -. Vuz    =        101.13 kN.
          -. Muy    =       -289.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63
```

```
          -. Vuy    =        311.51 kN.
          -. Muz    =       -919.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53

     ( ). Compute shear strength of concrete.
          -. Vuz       =      101.13 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1188.41 kN.
          -. phiVcz    = phi * Vcz =     1069.57 kN.

          -. Vuy       =      311.51 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1145.27 kN.
          -. phiVcy    = phi * Vcy =     1030.74 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2095.25 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5960.08 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2095.25 kN.
          -. phiVsz   = phi*Vsz =     1885.72 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2069.73 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6003.22 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2069.73 kN.
          -. phiVsy   = phi*Vsy =     1862.76 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     327.512 kN.
          -. Vr       =    2893.501 kN.
          -. Ratio    = Vu / Vr = 0.113  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 363.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 363.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0051 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116124,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1867.90       252.00       205.53       749.78       612.63
           ---------------------------------------------------------------------------
           DL+LL+Others    -1867.90       252.00       205.53       749.78       612.63
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6771.691 kN.
          -. Mry        =       924.679 kN-m.
          -. Mrz        =      2740.754 kN-m.
          -. Mr         =      2892.536 kN-m.
          -. Pu/Pr      =   0.276  --->  O.K !
          -. Muy/Mry    =   0.273  --->  O.K !
          -. Muz/Mrz    =   0.274  --->  O.K !
          -. Mu/Mr      =   0.276  --->  O.K !
          -. Ratio      =   0.276  --->  O.K !

 =======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 =======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5428.38 kN.
          -. Vuz    =         89.09 kN.
          -. Muy    =       -239.11 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.69
```

```
          -. Vuy    =        277.19 kN.
          -. Muz    =       -764.11 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.95 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.60

     ( ). Compute shear strength of concrete.
          -. Vuz       =       89.09 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1217.22 kN.
          -. phiVcz    = phi * Vcz =     1095.50 kN.

          -. Vuy       =      277.19 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1174.29 kN.
          -. phiVcy    = phi * Vcy =     1056.86 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2111.52 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5931.26 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2111.52 kN.
          -. phiVsz   = phi*Vsz =     1900.36 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2087.06 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5974.19 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2087.06 kN.
          -. phiVsy   = phi*Vsy =     1878.35 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     291.154 kN.
          -. Vr       =    2935.217 kN.
          -. Ratio    = Vu / Vr = 0.099  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 323.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 323.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0057 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0056 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116125,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1855.98       205.53       163.55       612.63       488.41
           ---------------------------------------------------------------------------
           DL+LL+Others    -1855.98       205.53       163.55       612.63       488.41
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7556.971 kN.
          -. Mry        =       826.191 kN-m.
          -. Mrz        =      2474.464 kN-m.
          -. Mr         =      2608.747 kN-m.
          -. Pu/Pr      =   0.246  --->  O.K !
          -. Muy/Mry    =   0.249  --->  O.K !
          -. Muz/Mrz    =   0.248  --->  O.K !
          -. Mu/Mr      =   0.249  --->  O.K !
          -. Ratio      =   0.249  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5445.11 kN.
          -. Vuz    =         80.29 kN.
          -. Muy    =       -194.64 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.47 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75
```

```
          -. Vuy    =       251.59 kN.
          -. Muz    =      -625.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.66

     ( ). Compute shear strength of concrete.
          -. Vuz       =      80.29 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1243.18 kN.
          -. phiVcz    = phi * Vcz =     1118.86 kN.

          -. Vuy       =     251.59 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1200.49 kN.
          -. phiVcy    = phi * Vcy =     1080.44 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2125.66 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5905.31 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2125.66 kN.
          -. phiVsz   = phi*Vsz =     1913.10 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2102.14 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5948.00 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2102.14 kN.
          -. phiVsy   = phi*Vsy =     1891.93 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     264.091 kN.
          -. Vr       =    2972.364 kN.
          -. Ratio    = Vu / Vr = 0.089  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 293.43 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 293.43 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0062 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0062 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0062 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116126,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5461.82      -154.56      -118.41      -499.77      -385.58
           ------------------------------------------------------------------------------
            DL+LL+Others     5461.82      -154.56      -118.41      -499.77      -385.58
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      118.41 kN-m.
           -. End Moments (My2) =      154.56 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -154.56 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -154.56 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      385.58 kN-m.
          -. End Moments (Mz2) =      499.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -499.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -499.77 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24029.257 kN.
          -. Mry        =       678.334 kN-m.
          -. Mrz        =      2199.505 kN-m.
          -. Mr         =      2301.730 kN-m.
          -. Pu/Pr      =   0.227  --->  O.K !
          -. Muy/Mry    =   0.228  --->  O.K !
          -. Muz/Mrz    =   0.227  --->  O.K !
          -. Mu/Mr      =   0.228  --->  O.K !
          -. Ratio      =   0.228  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5461.82 kN.
          -. Vuz    =         72.42 kN.
          -. Muy    =       -154.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81

          -. Vuy    =        228.40 kN.
          -. Muz    =       -499.77 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 72.42 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1267.57 kN.
-. phiVcz = phi * Vcz = 1140.82 kN.

-. Vuy = 228.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1225.15 kN.
-. phiVcy = phi * Vcy = 1102.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2138.55 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5880.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2138.55 kN.
-. phiVsz = phi*Vsz = 1924.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2115.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5923.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2115.89 kN.
-. phiVsy = phi*Vsy = 1904.30 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 239.610 kN.
-. Vr = 3006.940 kN.
-. Ratio = Vu / Vr = 0.080 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 266.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 266.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0067 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0067 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0067 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116127,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5495.19      -118.41       -85.97      -385.58      -282.43
           ------------------------------------------------------------------------------
            DL+LL+Others     5495.19      -118.41       -85.97      -385.58      -282.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       85.97 kN-m.
           -. End Moments (My2) =      118.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -85.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -85.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      282.43 kN-m.
          -. End Moments (Mz2) =      385.58 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -282.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -282.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       382.034 kN-m.
          -. Mrz        =      1254.224 kN-m.
          -. Mr         =      1311.117 kN-m.
          -. Pu/Pr      =   0.225  --->  O.K !
          -. Muy/Mry    =   0.225  --->  O.K !
          -. Muz/Mrz    =   0.225  --->  O.K !
          -. Mu/Mr      =   0.225  --->  O.K !
          -. Ratio      =   0.225  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5478.54 kN.
          -. Vuz    =         65.02 kN.
          -. Muy    =       -118.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        206.32 kN.
          -. Muz    =       -385.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 65.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1290.60 kN.
-. phiVcz = phi * Vcz = 1161.54 kN.

-. Vuy = 206.32 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1248.48 kN.
-. phiVcy = phi * Vcy = 1123.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2150.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5857.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2150.37 kN.
-. phiVsz = phi*Vsz = 1935.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2128.50 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5900.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2128.50 kN.
-. phiVsy = phi*Vsy = 1915.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 216.328 kN.
-. Vr = 3039.278 kN.
-. Ratio = Vu / Vr = 0.071 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 240.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 240.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0071 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0071 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0071 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116128,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          5511.90       -85.97       -56.91      -282.43      -189.46
           ---------------------------------------------------------------------------
            DL+LL+Others    5511.90       -85.97       -56.91      -282.43      -189.46
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       56.91 kN-m.
           -. End Moments (My2) =       85.97 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -56.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -56.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      189.46 kN-m.
          -. End Moments (Mz2) =      282.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -189.46 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -189.46 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       252.163 kN-m.
          -. Mrz        =       838.801 kN-m.
          -. Mr         =       875.885 kN-m.
          -. Pu/Pr      =   0.226  --->  O.K !
          -. Muy/Mry    =   0.226  --->  O.K !
          -. Muz/Mrz    =   0.226  --->  O.K !
          -. Mu/Mr      =   0.226  --->  O.K !
          -. Ratio      =   0.226  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5495.24 kN.
          -. Vuz    =         58.28 kN.
          -. Muy    =        -85.97 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90

          -. Vuy    =        185.97 kN.
          -. Muz    =       -282.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.30 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.81
```

( ). Compute shear strength of concrete.
-. Vuz = 58.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1312.06 kN.
-. phiVcz = phi * Vcz = 1180.85 kN.

-. Vuy = 185.97 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1270.25 kN.
-. phiVcy = phi * Vcy = 1143.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2161.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5836.43 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2161.08 kN.
-. phiVsz = phi*Vsz = 1944.97 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2139.94 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5878.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2139.94 kN.
-. phiVsy = phi*Vsy = 1925.95 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 194.884 kN.
-. Vr = 3069.170 kN.
-. Ratio = Vu / Vr = 0.063 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 216.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 216.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0075 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0075 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0075 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116129,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5528.59       -56.91       -33.67      -189.46      -114.25
           ------------------------------------------------------------------------------
            DL+LL+Others     5528.59       -56.91       -33.67      -189.46      -114.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       33.67 kN-m.
           -. End Moments (My2) =       56.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -33.67 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -33.67 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      114.25 kN-m.
          -. End Moments (Mz2) =      189.46 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -114.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -114.25 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       148.800 kN-m.
          -. Mrz        =       504.281 kN-m.
          -. Mr         =       525.776 kN-m.
          -. Pu/Pr      =   0.227  --->  O.K !
          -. Muy/Mry    =   0.226  --->  O.K !
          -. Muz/Mrz    =   0.227  --->  O.K !
          -. Mu/Mr      =   0.227  --->  O.K !
          -. Ratio      =   0.227  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5511.94 kN.
          -. Vuz    =         46.64 kN.
          -. Muy    =        -56.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        150.45 kN.
          -. Muz    =       -189.46 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86
```

( ). Compute shear strength of concrete.
-. Vuz = 46.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1334.81 kN.
-. phiVcz = phi * Vcz = 1201.33 kN.

-. Vuy = 150.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1293.37 kN.
-. phiVcy = phi * Vcy = 1164.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2172.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5813.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2172.15 kN.
-. phiVsz = phi*Vsz = 1954.94 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2151.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5855.11 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2151.77 kN.
-. phiVsy = phi*Vsy = 1936.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 157.514 kN.
-. Vr = 3100.626 kN.
-. Ratio = Vu / Vr = 0.051 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 175.02 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 175.02 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0079 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0079 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0079 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116130,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5545.28       -33.67       -17.79      -114.25       -61.79
           ------------------------------------------------------------------------------
            DL+LL+Others     5545.28       -33.67       -17.79      -114.25       -61.79
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       17.79 kN-m.
           -. End Moments (My2) =       33.67 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -17.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -17.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       61.79 kN-m.
          -. End Moments (Mz2) =      114.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -61.79 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -61.79 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =        78.321 kN-m.
           -. Mrz        =       271.917 kN-m.
           -. Mr         =       282.971 kN-m.
           -. Pu/Pr      =   0.227  --->  O.K !
           -. Muy/Mry    =   0.227  --->  O.K !
           -. Muz/Mrz    =   0.227  --->  O.K !
           -. Mu/Mr      =   0.227  --->  O.K !
           -. Ratio      =   0.227  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       5528.63 kN.
           -. Vuz    =         31.92 kN.
           -. Muy    =        -33.67 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.79 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.00

           -. Vuy    =        104.95 kN.
           -. Muz    =       -114.25 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.03 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 31.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1356.48 kN.
-. phiVcz = phi * Vcz = 1220.83 kN.

-. Vuy = 104.95 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1315.43 kN.
-. phiVcy = phi * Vcy = 1183.89 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2182.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5792.00 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2182.42 kN.
-. phiVsz = phi*Vsz = 1964.18 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2162.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5833.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2162.74 kN.
-. phiVsy = phi*Vsy = 1946.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 109.695 kN.
-. Vr = 3130.358 kN.
-. Ratio = Vu / Vr = 0.035 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 121.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 121.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0083 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0083 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0083 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116131,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5561.97       -17.79        -7.86       -61.79       -28.18
           ------------------------------------------------------------------------------
            DL+LL+Others     5561.97       -17.79        -7.86       -61.79       -28.18
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.86 kN-m.
           -. End Moments (My2) =       17.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.86 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.86 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       28.18 kN-m.
          -. End Moments (Mz2) =       61.79 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -28.18 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -28.18 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        34.494 kN-m.
          -. Mrz        =       123.649 kN-m.
          -. Mr         =       128.370 kN-m.
          -. Pu/Pr      =   0.228  --->  O.K !
          -. Muy/Mry    =   0.228  --->  O.K !
          -. Muz/Mrz    =   0.228  --->  O.K !
          -. Mu/Mr      =   0.228  --->  O.K !
          -. Ratio      =   0.228  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5561.97 kN.
          -. Vuz    =         19.95 kN.
          -. Muy    =         -7.86 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =         67.26 kN.
          -. Muz    =        -28.18 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 19.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1371.93 kN.
-. phiVcz = phi * Vcz = 1234.74 kN.

-. Vuy = 67.26 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1331.18 kN.
-. phiVcy = phi * Vcy = 1198.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2189.58 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5776.56 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2189.58 kN.
-. phiVsz = phi*Vsz = 1970.62 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2170.40 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5817.31 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2170.40 kN.
-. phiVsy = phi*Vsy = 1953.36 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 70.155 kN.
-. Vr = 3151.427 kN.
-. Ratio = Vu / Vr = 0.022 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 77.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 77.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0087 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0087 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0087 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116132,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5578.64        -7.86        -2.51       -28.18        -9.39
           ------------------------------------------------------------------------------
            DL+LL+Others     5578.64        -7.86        -2.51       -28.18        -9.39
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.51 kN-m.
           -. End Moments (My2) =        7.86 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        9.39 kN-m.
          -. End Moments (Mz2) =       28.18 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -9.39 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -9.39 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        10.956 kN-m.
          -. Mrz        =        41.099 kN-m.
          -. Mr         =        42.534 kN-m.
          -. Pu/Pr      =   0.229  --->  O.K !
          -. Muy/Mry    =   0.229  --->  O.K !
          -. Muz/Mrz    =   0.229  --->  O.K !
          -. Mu/Mr      =   0.229  --->  O.K !
          -. Ratio      =   0.229  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5578.64 kN.
          -. Vuz    =         10.78 kN.
          -. Muy    =         -2.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.66 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.06

          -. Vuy    =         37.61 kN.
          -. Muz    =         -9.39 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.88 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.97
```

( ). Compute shear strength of concrete.
-. Vuz = 10.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1381.26 kN.
-. phiVcz = phi * Vcz = 1243.14 kN.

-. Vuy = 37.61 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1340.70 kN.
-. phiVcy = phi * Vcy = 1206.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2193.85 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5767.22 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2193.85 kN.
-. phiVsz = phi*Vsz = 1974.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2174.97 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5807.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2174.97 kN.
-. phiVsy = phi*Vsy = 1957.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 39.123 kN.
-. Vr = 3164.102 kN.
-. Ratio = Vu / Vr = 0.012 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 43.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 43.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0089 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0089 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0089 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116133,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5595.31        -2.51        -0.37        -9.39        -1.35
           ------------------------------------------------------------------------------
            DL+LL+Others     5595.31        -2.51        -0.37        -9.39        -1.35
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.37 kN-m.
           -. End Moments (My2) =        2.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.37 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.37 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.35 kN-m.
          -. End Moments (Mz2) =        9.39 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.35 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.35 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         1.630 kN-m.
          -. Mrz        =         5.897 kN-m.
          -. Mr         =         6.118 kN-m.
          -. Pu/Pr      =   0.229  --->  O.K !
          -. Muy/Mry    =   0.229  --->  O.K !
          -. Muz/Mrz    =   0.229  --->  O.K !
          -. Mu/Mr      =   0.229  --->  O.K !
          -. Ratio      =   0.229  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5595.31 kN.
          -. Vuz    =          4.39 kN.
          -. Muy    =         -0.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.07

          -. Vuy    =         16.10 kN.
          -. Muz    =         -1.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.98
```

( ). Compute shear strength of concrete.
-. Vuz = 4.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1387.68 kN.
-. phiVcz = phi * Vcz = 1248.92 kN.

-. Vuy = 16.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1347.26 kN.
-. phiVcy = phi * Vcy = 1212.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2196.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5760.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2196.75 kN.
-. phiVsz = phi*Vsz = 1977.08 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2178.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5801.23 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2178.08 kN.
-. phiVsy = phi*Vsy = 1960.27 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 16.683 kN.
-. Vr = 3172.802 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 18.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 18.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0090 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0090 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0090 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116134,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5611.97        -0.37         0.00        -1.35         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5611.97        -0.37         0.00        -1.35         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.37 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        1.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.230  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.230  --->  O.K !
          -. Ratio      =   0.230  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5611.97 kN.
          -. Vuz    =          0.75 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.99

          -. Vuy    =          2.70 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.99
```

( ). Compute shear strength of concrete.
-. Vuz = 0.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1350.77 kN.
-. phiVcz = phi * Vcz = 1215.69 kN.

-. Vuy = 2.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1350.77 kN.
-. phiVcy = phi * Vcy = 1215.69 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2179.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5797.72 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2179.74 kN.
-. phiVsz = phi*Vsz = 1961.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2179.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5797.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2179.74 kN.
-. phiVsy = phi*Vsy = 1961.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 2.806 kN.
-. Vr = 3177.452 kN.
-. Ratio = Vu / Vr =8.830e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 3.12 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 3.12 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0090 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0090 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0090 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116202,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2013.33       862.42       547.45      1851.48      1155.59
           ---------------------------------------------------------------------------
           DL+LL+Others    -2013.33       862.42       547.45      1851.48      1155.59
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3814.960 kN.
          -. Mry        =      1646.541 kN-m.
          -. Mrz        =      3532.476 kN-m.
          -. Mr         =      3897.369 kN-m.
          -. Pu/Pr      =   0.528  --->  O.K !
          -. Muy/Mry    =   0.524  --->  O.K !
          -. Muz/Mrz    =   0.524  --->  O.K !
          -. Mu/Mr      =   0.528  --->  O.K !
          -. Ratio      =   0.528  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5007.10 kN.
          -. Vuz    =        692.70 kN.
          -. Muy    =       -996.04 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  35.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.04
```

```
          -. Vuy    =       1447.17 kN.
          -. Muz    =      -2085.60 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   1.95

     ( ). Compute shear strength of concrete.
          -. Vuz       =      692.70 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      923.48 kN.
          -. phiVcz    = phi * Vcz =      831.13 kN.

          -. Vuy       =     1447.17 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      881.31 kN.
          -. phiVcy    = phi * Vcy =      793.18 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1911.24 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6225.01 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1911.24 kN.
          -. phiVsz   = phi*Vsz =     1720.12 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1874.63 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6267.18 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1874.63 kN.
          -. phiVsy   = phi*Vsy =     1687.16 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1604.415 kN.
          -. Vr       =    2480.345 kN.
          -. Ratio    = Vu / Vr = 0.647  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1782.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1782.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116203,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -2001.56       547.45       432.08      1155.59       520.89
           ---------------------------------------------------------------------------
           DL+LL+Others    -2001.56       547.45       432.08      1155.59       520.89
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5312.892 kN.
          -. Mry        =      1458.508 kN-m.
          -. Mrz        =      3076.968 kN-m.
          -. Mr         =      3405.140 kN-m.
          -. Pu/Pr      =   0.377  --->  O.K !
          -. Muy/Mry    =   0.375  --->  O.K !
          -. Muz/Mrz    =   0.376  --->  O.K !
          -. Mu/Mr      =   0.377  --->  O.K !
          -. Ratio      =   0.377  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5023.97 kN.
          -. Vuz    =        634.58 kN.
          -. Muy    =       -661.89 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.24
```

-. Vuy = 1325.60 kN.
-. Muz = -1362.62 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.76 Deg. [Clause 5.8.3.4.2]
-. betay = 2.15

( ). Compute shear strength of concrete.
-. Vuz = 634.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1013.38 kN.
-. phiVcz = phi * Vcz = 912.04 kN.

-. Vuy = 1325.60 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 970.30 kN.
-. phiVcy = phi * Vcy = 873.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1981.71 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6135.11 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1981.71 kN.
-. phiVsz = phi*Vsz = 1783.54 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1949.15 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6178.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1949.15 kN.
-. phiVsy = phi*Vsy = 1754.23 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1469.664 kN.
-. Vr = 2627.507 kN.
-. Ratio = Vu / Vr = 0.559 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1632.96 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1632.96 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116204,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1989.77       432.08       390.79       520.89        -0.67
           ------------------------------------------------------------------------------
            DL+LL+Others    -1989.77       432.08       390.79       520.89        -0.67
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7571.810 kN.
          -. Mry        =      1657.663 kN-m.
          -. Mrz        =      1998.214 kN-m.
          -. Mr         =      2596.287 kN-m.
          -. Pu/Pr      =   0.263  --->  O.K !
          -. Muy/Mry    =   0.261  --->  O.K !
          -. Muz/Mrz    =   0.261  --->  O.K !
          -. Mu/Mr      =   0.263  --->  O.K !
          -. Ratio      =   0.263  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5057.48 kN.
          -. Vuz    =        575.81 kN.
          -. Muy    =       -469.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.82 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.36
```

-. Vuy = 1203.07 kN.
-. Muz = -154.28 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.22 Deg. [Clause 5.8.3.4.2]
-. betay = 2.27

( ). Compute shear strength of concrete.
-. Vuz = 575.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1066.75 kN.
-. phiVcz = phi * Vcz = 960.08 kN.

-. Vuy = 1203.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1023.42 kN.
-. phiVcy = phi * Vcy = 921.08 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2019.30 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6081.73 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2019.30 kN.
-. phiVsz = phi*Vsz = 1817.37 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1989.01 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6125.06 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1989.01 kN.
-. phiVsy = phi*Vsy = 1790.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1333.765 kN.
-. Vr = 2711.186 kN.
-. Ratio = Vu / Vr = 0.492 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1481.96 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1481.96 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116205,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1965.99       390.79       419.02        -0.67       513.21
           ---------------------------------------------------------------------------
           DL+LL+Others    -1965.99       390.79       419.02        -0.67       513.21
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7624.986 kN.
          -. Mry        =      1628.598 kN-m.
          -. Mrz        =      1996.049 kN-m.
          -. Mr         =      2576.149 kN-m.
          -. Pu/Pr      =   0.258  --->  O.K !
          -. Muy/Mry    =   0.257  --->  O.K !
          -. Muz/Mrz    =   0.257  --->  O.K !
          -. Mu/Mr      =   0.258  --->  O.K !
          -. Ratio      =   0.258  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5074.34 kN.
          -. Vuz    =        517.11 kN.
          -. Muy    =       -481.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42
```

```
          -. Vuy    =       1080.69 kN.
          -. Muz    =       -643.45 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.33

     ( ). Compute shear strength of concrete.
          -. Vuz       =      517.11 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1094.91 kN.
          -. phiVcz    = phi * Vcz =      985.42 kN.

          -. Vuy       =     1080.69 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1051.53 kN.
          -. phiVcy    = phi * Vcy =      946.38 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2038.02 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6053.57 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2038.02 kN.
          -. phiVsz   = phi*Vsz =     1834.22 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2008.87 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6096.96 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2008.87 kN.
          -. phiVsy   = phi*Vsy =     1807.99 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1198.037 kN.
          -. Vr       =    2754.363 kN.
          -. Ratio    = Vu / Vr = 0.435  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1331.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1331.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116206,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1954.19       419.02       556.26       513.21       982.99
           ---------------------------------------------------------------------------
           DL+LL+Others    -1954.19       419.02       556.26       513.21       982.99
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5708.823 kN.
          -. Mry        =      1615.788 kN-m.
          -. Mrz        =      2845.797 kN-m.
          -. Mr         =      3272.511 kN-m.
          -. Pu/Pr      =   0.342  --->  O.K !
          -. Muy/Mry    =   0.344  --->  O.K !
          -. Muz/Mrz    =   0.345  --->  O.K !
          -. Mu/Mr      =   0.345  --->  O.K !
          -. Ratio      =   0.345  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5091.19 kN.
          -. Vuz    =        459.19 kN.
          -. Muy    =       -602.75 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.40
```

```
          -. Vuy    =       959.91 kN.
          -. Muz    =     -1089.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.30

     ( ). Compute shear strength of concrete.
          -. Vuz       =     459.19 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1082.14 kN.
          -. phiVcz    = phi * Vcz =      973.92 kN.

          -. Vuy       =     959.91 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1038.77 kN.
          -. phiVcy    = phi * Vcy =      934.89 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2029.62 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6066.35 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2029.62 kN.
          -. phiVsz   = phi*Vsz =     1826.66 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1999.96 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6109.72 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1999.96 kN.
          -. phiVsy   = phi*Vsy =     1799.96 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1064.092 kN.
          -. Vr       =    2734.854 kN.
          -. Ratio    = Vu / Vr = 0.389  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1182.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1182.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116207,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1942.38       556.26       716.92       982.99      1396.09
           ---------------------------------------------------------------------------
           DL+LL+Others    -1942.38       556.26       716.92       982.99      1396.09
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4544.748 kN.
          -. Mry        =      1671.818 kN-m.
          -. Mrz        =      3255.813 kN-m.
          -. Mr         =      3659.958 kN-m.
          -. Pu/Pr      =   0.427  --->  O.K !
          -. Muy/Mry    =   0.429  --->  O.K !
          -. Muz/Mrz    =   0.429  --->  O.K !
          -. Mu/Mr      =   0.429  --->  O.K !
          -. Ratio      =   0.429  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5108.03 kN.
          -. Vuz    =        402.79 kN.
          -. Muy    =       -748.90 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.02 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.31
```

```
          -. Vuy    =       842.26 kN.
          -. Muz    =     -1480.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.22

     ( ). Compute shear strength of concrete.
          -. Vuz       =     402.79 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1045.16 kN.
          -. phiVcz    = phi * Vcz =      940.64 kN.

          -. Vuy       =     842.26 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1001.91 kN.
          -. phiVcy    = phi * Vcy =      901.72 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2004.44 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6103.33 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2004.44 kN.
          -. phiVsz   = phi*Vsz =     1804.00 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1973.24 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6146.58 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1973.24 kN.
          -. phiVsy   = phi*Vsy =     1775.92 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     933.615 kN.
          -. Vr       =    2677.632 kN.
          -. Ratio    = Vu / Vr = 0.349  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1037.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1037.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116208,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1930.57       716.92       865.36      1396.09      1753.02
           ---------------------------------------------------------------------------
           DL+LL+Others    -1930.57       716.92       865.36      1396.09      1753.02
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3816.383 kN.
          -. Mry        =      1720.735 kN-m.
          -. Mrz        =      3496.691 kN-m.
          -. Mr         =      3897.150 kN-m.
          -. Pu/Pr      =   0.506  --->  O.K !
          -. Muy/Mry    =   0.503  --->  O.K !
          -. Muz/Mrz    =   0.501  --->  O.K !
          -. Mu/Mr      =   0.506  --->  O.K !
          -. Ratio      =   0.506  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5124.87 kN.
          -. Vuz    =        348.66 kN.
          -. Muy    =       -883.88 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

-. Vuy = 729.25 kN.
-. Muz = -1815.83 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.74 Deg. [Clause 5.8.3.4.2]
-. betay = 2.15

( ). Compute shear strength of concrete.
-. Vuz = 348.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1015.91 kN.
-. phiVcz = phi * Vcz = 914.32 kN.

-. Vuy = 729.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 972.82 kN.
-. phiVcy = phi * Vcy = 875.54 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1983.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6132.58 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1983.56 kN.
-. phiVsz = phi*Vsz = 1785.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1951.11 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6175.67 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1951.11 kN.
-. phiVsy = phi*Vsy = 1756.00 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 808.309 kN.
-. Vr = 2631.531 kN.
-. Ratio = Vu / Vr = 0.307 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 898.12 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 898.12 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116209,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1918.75       865.36       996.85      1753.02      2048.21
           ---------------------------------------------------------------------------
           DL+LL+Others    -1918.75       865.36       996.85      1753.02      2048.21
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3417.453 kN.
          -. Mry        =      1751.445 kN-m.
          -. Mrz        =      3621.876 kN-m.
          -. Mr         =      4023.127 kN-m.
          -. Pu/Pr      =   0.561  --->  O.K !
          -. Muy/Mry    =   0.569  --->  O.K !
          -. Muz/Mrz    =   0.566  --->  O.K !
          -. Mu/Mr      =   0.569  --->  O.K !
          -. Ratio      =   0.569  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5141.70 kN.
          -. Vuz    =        289.24 kN.
          -. Muy    =      -1003.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
```

```
          -. Vuy    =       605.18 kN.
          -. Muz    =     -2091.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.11

     ( ). Compute shear strength of concrete.
          -. Vuz       =     289.24 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     995.70 kN.
          -. phiVcz    = phi * Vcz =     896.13 kN.

          -. Vuy       =     605.18 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     952.76 kN.
          -. phiVcy    = phi * Vcy =     857.48 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1968.60 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6152.78 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1968.60 kN.
          -. phiVsz   = phi*Vsz =     1771.74 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1935.27 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6195.73 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1935.27 kN.
          -. phiVsy   = phi*Vsy =     1741.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     670.745 kN.
          -. Vr       =    2599.227 kN.
          -. Ratio    = Vu / Vr = 0.258  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 745.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 745.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116210,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1906.93       996.85      1090.21      2048.21      2249.20
           ---------------------------------------------------------------------------
           DL+LL+Others    -1906.93       996.85      1090.21      2048.21      2249.20
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3113.364 kN.
          -. Mry        =      1797.616 kN-m.
          -. Mrz        =      3695.854 kN-m.
          -. Mr         =      4109.837 kN-m.
          -. Pu/Pr      =   0.612  --->  O.K !
          -. Muy/Mry    =   0.606  --->  O.K !
          -. Muz/Mrz    =   0.609  --->  O.K !
          -. Mu/Mr      =   0.612  --->  O.K !
          -. Ratio      =   0.612  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5158.52 kN.
          -. Vuz    =        198.64 kN.
          -. Muy    =      -1086.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
```

```
          -. Vuy    =       415.75 kN.
          -. Muz    =     -2274.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.99 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.10

     ( ). Compute shear strength of concrete.
          -. Vuz       =     198.64 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     992.83 kN.
          -. phiVcz    = phi * Vcz =     893.55 kN.

          -. Vuy       =     415.75 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     949.91 kN.
          -. phiVcy    = phi * Vcy =     854.92 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1966.44 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6155.66 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1966.44 kN.
          -. phiVsz   = phi*Vsz =     1769.79 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1932.98 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6198.58 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1932.98 kN.
          -. phiVsy   = phi*Vsy =     1739.68 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     460.769 kN.
          -. Vr       =    2594.601 kN.
          -. Ratio    = Vu / Vr = 0.178  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 511.97 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 511.97 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0004 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0004 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0004 m^2.
- As = 0.0363 m^2.
- As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116211,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1895.09      1090.21      1143.20      2249.20      2363.81
           ---------------------------------------------------------------------------
           DL+LL+Others    -1895.09      1090.21      1143.20      2249.20      2363.81
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2998.353 kN.
          -. Mry        =      1807.467 kN-m.
          -. Mrz        =      3726.514 kN-m.
          -. Mr         =      4141.719 kN-m.
          -. Pu/Pr      =   0.632  --->  O.K !
          -. Muy/Mry    =   0.632  --->  O.K !
          -. Muz/Mrz    =   0.634  --->  O.K !
          -. Mu/Mr      =   0.634  --->  O.K !
          -. Ratio      =   0.634  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5175.34 kN.
          -. Vuz    =        115.97 kN.
          -. Muy    =      -1130.88 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.47 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.21
```

```
          -. Vuy    =       241.30 kN.
          -. Muz    =     -2374.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.11

     ( ). Compute shear strength of concrete.
          -. Vuz       =     115.97 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      998.11 kN.
          -. phiVcz    = phi * Vcz =      898.30 kN.

          -. Vuy       =     241.30 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      955.15 kN.
          -. phiVcy    = phi * Vcy =      859.63 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1970.40 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6150.38 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1970.40 kN.
          -. phiVsz   = phi*Vsz =     1773.36 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1937.18 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6193.34 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1937.18 kN.
          -. phiVsy   = phi*Vsy =     1743.46 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     267.727 kN.
          -. Vr       =    2603.091 kN.
          -. Ratio    = Vu / Vr = 0.103  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 297.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 297.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116212,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1883.26      1143.20      1160.08      2363.81      2401.08
           ---------------------------------------------------------------------------
           DL+LL+Others    -1883.26      1143.20      1160.08      2363.81      2401.08
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2960.229 kN.
          -. Mry        =      1810.352 kN-m.
          -. Mrz        =      3736.846 kN-m.
          -. Mr         =      4152.276 kN-m.
          -. Pu/Pr      =   0.636  --->  O.K !
          -. Muy/Mry    =   0.641  --->  O.K !
          -. Muz/Mrz    =   0.643  --->  O.K !
          -. Mu/Mr      =   0.643  --->  O.K !
          -. Ratio      =   0.643  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5192.15 kN.
          -. Vuz    =         71.59 kN.
          -. Muy    =      -1141.29 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.36 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

```
          -. Vuy    =         85.75 kN.
          -. Muz    =      -2399.72 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.14

     ( ). Compute shear strength of concrete.
          -. Vuz       =       71.59 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1008.84 kN.
          -. phiVcz    = phi * Vcz =      907.96 kN.

          -. Vuy       =       85.75 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      965.80 kN.
          -. phiVcy    = phi * Vcy =      869.22 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1978.38 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6139.64 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1978.38 kN.
          -. phiVsz   = phi*Vsz =     1780.54 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1945.62 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6182.68 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1945.62 kN.
          -. phiVsy   = phi*Vsy =     1751.06 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     111.705 kN.
          -. Vr       =    2620.282 kN.
          -. Ratio    = Vu / Vr = 0.043  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 124.12 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 124.12 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0001 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116213,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1883.40      1160.08      1145.73      2401.08      2372.66
           ---------------------------------------------------------------------------
           DL+LL+Others    -1883.40      1160.08      1145.73      2401.08      2372.66
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2960.229 kN.
          -. Mry        =      1810.352 kN-m.
          -. Mrz        =      3736.846 kN-m.
          -. Mr         =      4152.276 kN-m.
          -. Pu/Pr      =   0.636  --->  O.K !
          -. Muy/Mry    =   0.641  --->  O.K !
          -. Muz/Mrz    =   0.643  --->  O.K !
          -. Mu/Mr      =   0.643  --->  O.K !
          -. Ratio      =   0.643  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3554.43 kN.
          -. Vuz    =        144.45 kN.
          -. Muy    =      -2002.98 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.25 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51
```

-. Vuy = 45.49 kN.
-. Muz = -1112.75 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.60 Deg. [Clause 5.8.3.4.2]
-. betay = 2.42

( ). Compute shear strength of concrete.
-. Vuz = 144.45 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1135.08 kN.
-. phiVcz = phi * Vcz = 1021.57 kN.

-. Vuy = 45.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1091.72 kN.
-. phiVcy = phi * Vcy = 982.55 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2063.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6013.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2063.49 kN.
-. phiVsz = phi*Vsz = 1857.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2035.94 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6056.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2035.94 kN.
-. phiVsy = phi*Vsy = 1832.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 151.445 kN.
-. Vr = 2814.892 kN.
-. Ratio = Vu / Vr = 0.054 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 168.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 168.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=====================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116214,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1871.55      1145.73      1104.73      2372.66      2288.78
           ---------------------------------------------------------------------------
           DL+LL+Others    -1871.55      1145.73      1104.73      2372.66      2288.78
           ---------------------------------------------------------------------------

 ===================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2960.209 kN.
          -. Mry        =      1809.477 kN-m.
          -. Mrz        =      3737.270 kN-m.
          -. Mr         =      4152.276 kN-m.
          -. Pu/Pr      =   0.632  --->  O.K !
          -. Muy/Mry    =   0.633  --->  O.K !
          -. Muz/Mrz    =   0.635  --->  O.K !
          -. Mu/Mr      =   0.635  --->  O.K !
          -. Ratio      =   0.635  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3571.15 kN.
          -. Vuz    =        209.67 kN.
          -. Muy    =      -1939.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51
```

```
          -. Vuy    =         91.97 kN.
          -. Muz    =      -1092.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41

     ( ). Compute shear strength of concrete.
          -. Vuz       =      209.67 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1133.90 kN.
          -. phiVcz    = phi * Vcz =     1020.51 kN.

          -. Vuy       =       91.97 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1090.54 kN.
          -. phiVcy    = phi * Vcy =      981.49 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2062.76 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6014.59 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2062.76 kN.
          -. phiVsz   = phi*Vsz =     1856.48 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2035.16 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6057.95 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2035.16 kN.
          -. phiVsy   = phi*Vsy =     1831.64 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     228.954 kN.
          -. Vr       =    2813.130 kN.
          -. Ratio    = Vu / Vr = 0.081  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 254.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 254.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116215,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1859.69      1104.73      1042.62      2288.78      2160.94
           ---------------------------------------------------------------------------
           DL+LL+Others    -1859.69      1104.73      1042.62      2288.78      2160.94
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3036.474 kN.
          -. Mry        =      1799.791 kN-m.
          -. Mrz        =      3718.462 kN-m.
          -. Mr         =      4131.126 kN-m.
          -. Pu/Pr      =   0.612  --->  O.K !
          -. Muy/Mry    =   0.614  --->  O.K !
          -. Muz/Mrz    =   0.616  --->  O.K !
          -. Mu/Mr      =   0.616  --->  O.K !
          -. Ratio      =   0.616  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5225.88 kN.
          -. Vuz    =        132.12 kN.
          -. Muy    =      -1077.97 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

```
          -. Vuy    =       268.97 kN.
          -. Muz    =     -2269.93 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.13

     ( ). Compute shear strength of concrete.
          -. Vuz       =     132.12 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1005.34 kN.
          -. phiVcz    = phi * Vcz =      904.80 kN.

          -. Vuy       =     268.97 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      962.32 kN.
          -. phiVcy    = phi * Vcy =      866.09 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1975.79 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6143.15 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1975.79 kN.
          -. phiVsz   = phi*Vsz =     1778.21 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1942.88 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6186.16 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1942.88 kN.
          -. phiVsy   = phi*Vsy =     1748.59 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     299.670 kN.
          -. Vr       =    2614.682 kN.
          -. Ratio    = Vu / Vr = 0.115  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 332.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 332.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-3.1968e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-2.2178e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-2.2178e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116216,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1847.83      1042.62       964.94      2160.94      2000.52
           ---------------------------------------------------------------------------
           DL+LL+Others    -1847.83      1042.62       964.94      2160.94      2000.52
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3159.728 kN.
          -. Mry        =      1778.530 kN-m.
          -. Mrz        =      3693.434 kN-m.
          -. Mr         =      4099.344 kN-m.
          -. Pu/Pr      =   0.585  --->  O.K !
          -. Muy/Mry    =   0.586  --->  O.K !
          -. Muz/Mrz    =   0.585  --->  O.K !
          -. Mu/Mr      =   0.586  --->  O.K !
          -. Ratio      =   0.586  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5242.66 kN.
          -. Vuz    =        158.13 kN.
          -. Muy    =      -1014.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

```
          -. Vuy    =       329.65 kN.
          -. Muz    =     -2136.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.15

     ( ). Compute shear strength of concrete.
          -. Vuz       =     158.13 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1014.39 kN.
          -. phiVcz    = phi * Vcz =      912.95 kN.

          -. Vuy       =     329.65 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      971.31 kN.
          -. phiVcy    = phi * Vcy =      874.18 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1982.45 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6134.10 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1982.45 kN.
          -. phiVsz   = phi*Vsz =     1784.20 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1949.93 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6177.18 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1949.93 kN.
          -. phiVsy   = phi*Vsy =     1754.94 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     365.616 kN.
          -. Vr       =    2629.116 kN.
          -. Ratio    = Vu / Vr = 0.139  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 406.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 406.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116217,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1835.95       964.94       877.00      2000.52      1818.56
           ---------------------------------------------------------------------------
           DL+LL+Others    -1835.95       964.94       877.00      2000.52      1818.56
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3343.505 kN.
          -. Mry        =      1751.091 kN-m.
          -. Mrz        =      3647.440 kN-m.
          -. Mr         =      4046.003 kN-m.
          -. Pu/Pr      =   0.549  --->  O.K !
          -. Muy/Mry    =   0.551  --->  O.K !
          -. Muz/Mrz    =   0.548  --->  O.K !
          -. Mu/Mr      =   0.551  --->  O.K !
          -. Ratio      =   0.551  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5259.44 kN.
          -. Vuz    =        175.93 kN.
          -. Muy    =       -935.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.16 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =       368.76 kN.
          -. Muz    =     -1972.55 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.18

     ( ). Compute shear strength of concrete.
          -. Vuz       =     175.93 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1029.61 kN.
          -. phiVcz    = phi * Vcz =      926.65 kN.

          -. Vuy       =     368.76 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      986.44 kN.
          -. phiVcy    = phi * Vcy =      887.79 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1993.45 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6118.88 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1993.45 kN.
          -. phiVsz   = phi*Vsz =     1794.11 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1961.59 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6162.05 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1961.59 kN.
          -. phiVsy   = phi*Vsy =     1765.43 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     408.578 kN.
          -. Vr       =    2653.224 kN.
          -. Ratio    = Vu / Vr = 0.154  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 453.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 453.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116218,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1824.08       877.00       783.70      1818.56      1625.32
           ---------------------------------------------------------------------------
           DL+LL+Others    -1824.08       877.00       783.70      1818.56      1625.32
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3583.270 kN.
          -. Mry        =      1722.676 kN-m.
          -. Mrz        =      3579.490 kN-m.
          -. Mr         =      3972.451 kN-m.
          -. Pu/Pr      =   0.509  --->  O.K !
          -. Muy/Mry    =   0.509  --->  O.K !
          -. Muz/Mrz    =   0.508  --->  O.K !
          -. Mu/Mr      =   0.509  --->  O.K !
          -. Ratio      =   0.509  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5276.21 kN.
          -. Vuz    =        184.58 kN.
          -. Muy    =       -848.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.32
```

```
          -. Vuy    =       387.95 kN.
          -. Muz    =     -1788.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.23

     ( ). Compute shear strength of concrete.
          -. Vuz       =     184.58 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1050.06 kN.
          -. phiVcz    = phi * Vcz =      945.05 kN.

          -. Vuy       =     387.95 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1006.78 kN.
          -. phiVcy    = phi * Vcy =      906.10 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2007.85 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6098.43 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2007.85 kN.
          -. phiVsz   = phi*Vsz =     1807.07 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1976.86 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6141.70 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1976.86 kN.
          -. phiVsy   = phi*Vsy =     1779.17 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     429.623 kN.
          -. Vr       =    2685.277 kN.
          -. Ratio    = Vu / Vr = 0.160  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 477.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 477.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116219,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1812.19       783.70       689.50      1625.32      1430.39
           ---------------------------------------------------------------------------
           DL+LL+Others    -1812.19       783.70       689.50      1625.32      1430.39
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3893.576 kN.
          -. Mry        =      1679.694 kN-m.
          -. Mrz        =      3488.569 kN-m.
          -. Mr         =      3871.884 kN-m.
          -. Pu/Pr      =   0.465  --->  O.K !
          -. Muy/Mry    =   0.467  --->  O.K !
          -. Muz/Mrz    =   0.466  --->  O.K !
          -. Mu/Mr      =   0.467  --->  O.K !
          -. Ratio      =   0.467  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5292.97 kN.
          -. Vuz    =        184.97 kN.
          -. Muy    =       -756.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.75 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.38
```

-. Vuy = 389.25 kN.
-. Muz = -1594.87 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.15 Deg. [Clause 5.8.3.4.2]
-. betay = 2.28

( ). Compute shear strength of concrete.
-. Vuz = 184.97 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1074.74 kN.
-. phiVcz = phi * Vcz = 967.26 kN.

-. Vuy = 389.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1031.38 kN.
-. phiVcy = phi * Vcy = 928.25 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2024.69 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6073.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2024.69 kN.
-. phiVsz = phi*Vsz = 1822.22 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1994.72 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6117.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1994.72 kN.
-. phiVsy = phi*Vsy = 1795.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 430.963 kN.
-. Vr = 2723.492 kN.
-. Ratio = Vu / Vr = 0.158 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 478.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 478.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116220,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1800.30       689.50       598.19      1430.39      1241.43
           ---------------------------------------------------------------------------
           DL+LL+Others    -1800.30       689.50       598.19      1430.39      1241.43
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4252.468 kN.
          -. Mry        =      1629.511 kN-m.
          -. Mrz        =      3382.798 kN-m.
          -. Mr         =      3754.814 kN-m.
          -. Pu/Pr      =   0.423  --->  O.K !
          -. Muy/Mry    =   0.423  --->  O.K !
          -. Muz/Mrz    =   0.423  --->  O.K !
          -. Mu/Mr      =   0.423  --->  O.K !
          -. Ratio      =   0.423  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5309.72 kN.
          -. Vuz    =        178.32 kN.
          -. Muy    =       -663.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.44
```

```
          -. Vuy    =       375.58 kN.
          -. Muz    =     -1400.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.34

     ( ). Compute shear strength of concrete.
          -. Vuz       =     178.32 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1102.52 kN.
          -. phiVcz    = phi * Vcz =      992.27 kN.

          -. Vuy       =     375.58 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1059.13 kN.
          -. phiVcy    = phi * Vcy =      953.22 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2042.95 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6045.97 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2042.95 kN.
          -. phiVsz   = phi*Vsz =     1838.66 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2014.11 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6089.35 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2014.11 kN.
          -. phiVsy   = phi*Vsy =     1812.70 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     415.763 kN.
          -. Vr       =    2765.919 kN.
          -. Ratio    = Vu / Vr = 0.150  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 461.96 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 461.96 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116221,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1788.40       598.19       511.38      1241.43      1061.63
           ---------------------------------------------------------------------------
           DL+LL+Others    -1788.40       598.19       511.38      1241.43      1061.63
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4706.741 kN.
          -. Mry        =      1565.636 kN-m.
          -. Mrz        =      3247.989 kN-m.
          -. Mr         =      3605.641 kN-m.
          -. Pu/Pr      =   0.380  --->  O.K !
          -. Muy/Mry    =   0.382  --->  O.K !
          -. Muz/Mrz    =   0.382  --->  O.K !
          -. Mu/Mr      =   0.382  --->  O.K !
          -. Ratio      =   0.382  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5326.47 kN.
          -. Vuz    =        168.91 kN.
          -. Muy    =       -574.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.28 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.50
```

```
          -. Vuy    =       355.98 kN.
          -. Muz    =     -1213.19 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.63 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41

     ( ). Compute shear strength of concrete.
          -. Vuz       =      168.91 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1131.51 kN.
          -. phiVcz    = phi * Vcz =     1018.36 kN.

          -. Vuy       =      355.98 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1088.15 kN.
          -. phiVcy    = phi * Vcy =      979.33 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2061.28 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6016.97 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2061.28 kN.
          -. phiVsz   = phi*Vsz =     1855.15 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2033.59 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6060.34 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2033.59 kN.
          -. phiVsy   = phi*Vsy =     1830.23 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     394.018 kN.
          -. Vr       =    2809.565 kN.
          -. Ratio    = Vu / Vr = 0.140  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 437.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 437.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116222,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1776.49       511.38       430.78      1061.63       894.55
           ---------------------------------------------------------------------------
           DL+LL+Others    -1776.49       511.38       430.78      1061.63       894.55
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5224.522 kN.
          -. Mry        =      1492.565 kN-m.
          -. Mrz        =      3093.252 kN-m.
          -. Mr         =      3434.525 kN-m.
          -. Pu/Pr      =   0.340  --->  O.K !
          -. Muy/Mry    =   0.343  --->  O.K !
          -. Muz/Mrz    =   0.343  --->  O.K !
          -. Mu/Mr      =   0.343  --->  O.K !
          -. Ratio      =   0.343  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5343.22 kN.
          -. Vuz    =        156.32 kN.
          -. Muy    =       -490.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.57
```

```
          -. Vuy    =       329.60 kN.
          -. Muz    =     -1035.45 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48

     ( ). Compute shear strength of concrete.
          -. Vuz       =     156.32 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1161.46 kN.
          -. phiVcz    = phi * Vcz =     1045.31 kN.

          -. Vuy       =     329.60 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1118.18 kN.
          -. phiVcy    = phi * Vcy =     1006.36 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2079.48 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5987.03 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2079.48 kN.
          -. phiVsz   = phi*Vsz =     1871.53 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2052.94 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6030.30 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2052.94 kN.
          -. phiVsy   = phi*Vsy =     1847.65 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     364.787 kN.
          -. Vr       =    2854.013 kN.
          -. Ratio    = Vu / Vr = 0.128  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 405.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 405.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0043 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0043 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116223,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1764.58       430.78       357.56       894.55       742.71
           ---------------------------------------------------------------------------
           DL+LL+Others    -1764.58       430.78       357.56       894.55       742.71
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5768.850 kN.
          -. Mry        =      1415.452 kN-m.
          -. Mrz        =      2929.679 kN-m.
          -. Mr         =      3253.694 kN-m.
          -. Pu/Pr      =   0.306  --->  O.K !
          -. Muy/Mry    =   0.304  --->  O.K !
          -. Muz/Mrz    =   0.305  --->  O.K !
          -. Mu/Mr      =   0.306  --->  O.K !
          -. Ratio      =   0.306  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5359.95 kN.
          -. Vuz    =        141.53 kN.
          -. Muy    =       -412.10 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.64
```

```
          -. Vuy    =       298.52 kN.
          -. Muz    =      -870.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54

     ( ). Compute shear strength of concrete.
          -. Vuz       =     141.53 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1191.52 kN.
          -. phiVcz    = phi * Vcz =     1072.37 kN.

          -. Vuy       =     298.52 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1148.40 kN.
          -. phiVcy    = phi * Vcy =     1033.56 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2097.03 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5956.97 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2097.03 kN.
          -. phiVsz   = phi*Vsz =     1887.33 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2071.63 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6000.09 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2071.63 kN.
          -. phiVsy   = phi*Vsy =     1864.47 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     330.371 kN.
          -. Vr       =    2898.028 kN.
          -. Ratio    = Vu / Vr = 0.114  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 367.08 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 367.08 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116224,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1752.66       357.56       292.48       742.71       607.66
           ---------------------------------------------------------------------------
           DL+LL+Others    -1752.66       357.56       292.48       742.71       607.66
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -6454.457 kN.
          -. Mry        =      1304.875 kN-m.
          -. Mrz        =      2717.061 kN-m.
          -. Mr         =      3014.153 kN-m.
          -. Pu/Pr      =   0.272  --->  O.K !
          -. Muy/Mry    =   0.274  --->  O.K !
          -. Muz/Mrz    =   0.273  --->  O.K !
          -. Mu/Mr      =   0.274  --->  O.K !
          -. Ratio      =   0.274  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5376.68 kN.
          -. Vuz    =        125.40 kN.
          -. Muy    =       -341.36 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70
```

```
          -. Vuy    =       264.61 kN.
          -. Muz    =      -721.61 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61

     ( ). Compute shear strength of concrete.
          -. Vuz       =     125.40 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1220.89 kN.
          -. phiVcz    = phi * Vcz =     1098.80 kN.

          -. Vuy       =     264.61 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1177.99 kN.
          -. phiVcy    = phi * Vcy =     1060.19 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2113.54 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5927.60 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2113.54 kN.
          -. phiVsz   = phi*Vsz =     1902.19 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2089.22 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5970.49 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2089.22 kN.
          -. phiVsy   = phi*Vsy =     1880.30 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     292.823 kN.
          -. Vr       =    2940.491 kN.
          -. Ratio    = Vu / Vr = 0.100  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 325.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 325.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0056 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0056 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116225,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1740.74       292.48       233.45       607.66       485.14
           ---------------------------------------------------------------------------
           DL+LL+Others    -1740.74       292.48       233.45       607.66       485.14
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -7122.057 kN.
          -. Mry        =      1197.673 kN-m.
          -. Mrz        =      2489.687 kN-m.
          -. Mr         =      2762.782 kN-m.
          -. Pu/Pr      =   0.244  --->  O.K !
          -. Muy/Mry    =   0.244  --->  O.K !
          -. Muz/Mrz    =   0.244  --->  O.K !
          -. Mu/Mr      =   0.244  --->  O.K !
          -. Ratio      =   0.244  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5393.40 kN.
          -. Vuz    =        113.46 kN.
          -. Muy    =       -278.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.45 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.76
```

```
          -. Vuy    =       239.53 kN.
          -. Muz    =      -589.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.73 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67

     ( ). Compute shear strength of concrete.
          -. Vuz       =     113.46 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1247.25 kN.
          -. phiVcz    = phi * Vcz =     1122.53 kN.

          -. Vuy       =     239.53 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1204.60 kN.
          -. phiVcy    = phi * Vcy =     1084.14 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2127.85 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5901.23 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2127.85 kN.
          -. phiVsz   = phi*Vsz =     1915.06 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2104.47 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5943.88 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2104.47 kN.
          -. phiVsy   = phi*Vsy =     1894.02 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     265.043 kN.
          -. Vr       =    2978.164 kN.
          -. Ratio    = Vu / Vr = 0.089  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 294.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 294.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0061 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0061 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0061 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116226,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5410.12      -221.96      -170.63      -469.54      -361.10
           ------------------------------------------------------------------------------
            DL+LL+Others     5410.12      -221.96      -170.63      -469.54      -361.10
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      170.63 kN-m.
           -. End Moments (My2) =      221.96 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -221.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -221.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      361.10 kN-m.
          -. End Moments (Mz2) =      469.54 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -469.54 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -469.54 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     23993.043 kN.
          -. Mry        =       986.486 kN-m.
          -. Mrz        =      2086.606 kN-m.
          -. Mr         =      2308.047 kN-m.
          -. Pu/Pr      =   0.225  --->  O.K !
          -. Muy/Mry    =   0.225  --->  O.K !
          -. Muz/Mrz    =   0.225  --->  O.K !
          -. Mu/Mr      =   0.225  --->  O.K !
          -. Ratio      =   0.225  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5410.12 kN.
          -. Vuz    =        102.69 kN.
          -. Muy    =       -221.96 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.82

          -. Vuy    =        216.88 kN.
          -. Muz    =       -469.54 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.56 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.72
```

( ). Compute shear strength of concrete.
-. Vuz = 102.69 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1271.99 kN.
-. phiVcz = phi * Vcz = 1144.79 kN.

-. Vuy = 216.88 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1229.62 kN.
-. phiVcy = phi * Vcy = 1106.66 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2140.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5876.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2140.84 kN.
-. phiVsz = phi*Vsz = 1926.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2118.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5918.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2118.33 kN.
-. phiVsy = phi*Vsy = 1906.50 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 239.964 kN.
-. Vr = 3013.160 kN.
-. Ratio = Vu / Vr = 0.080 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 266.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 266.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0066 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0066 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0066 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116227,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5443.48      -170.63      -124.40      -361.10      -263.39
           ------------------------------------------------------------------------------
            DL+LL+Others     5443.48      -170.63      -124.40      -361.10      -263.39
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      124.40 kN-m.
           -. End Moments (My2) =      170.63 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -124.40 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -124.40 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      263.39 kN-m.
          -. End Moments (Mz2) =      361.10 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -263.39 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -263.39 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       557.767 kN-m.
          -. Mrz        =      1180.821 kN-m.
          -. Mr         =      1305.925 kN-m.
          -. Pu/Pr      =   0.223  --->  O.K !
          -. Muy/Mry    =   0.223  --->  O.K !
          -. Muz/Mrz    =   0.223  --->  O.K !
          -. Mu/Mr      =   0.223  --->  O.K !
          -. Ratio      =   0.223  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5426.83 kN.
          -. Vuz    =         92.49 kN.
          -. Muy    =       -170.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.87

          -. Vuy    =        195.42 kN.
          -. Muz    =       -361.10 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.41 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.77
```

( ). Compute shear strength of concrete.
-. Vuz = 92.49 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1295.28 kN.
-. phiVcz = phi * Vcz = 1165.76 kN.

-. Vuy = 195.42 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1253.23 kN.
-. phiVcy = phi * Vcy = 1127.91 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2152.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5853.20 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2152.73 kN.
-. phiVsz = phi*Vsz = 1937.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2131.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5895.26 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2131.02 kN.
-. phiVsy = phi*Vsy = 1917.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 216.199 kN.
-. Vr = 3045.825 kN.
-. Ratio = Vu / Vr = 0.071 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 240.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 240.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0070 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0070 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0070 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116228,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5460.19      -124.40       -82.85      -263.39      -175.59
           ------------------------------------------------------------------------------
            DL+LL+Others     5460.19      -124.40       -82.85      -263.39      -175.59
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       82.85 kN-m.
           -. End Moments (My2) =      124.40 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -82.85 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -82.85 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      175.59 kN-m.
          -. End Moments (Mz2) =      263.39 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -175.59 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -175.59 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =       370.312 kN-m.
           -. Mrz        =       784.792 kN-m.
           -. Mr         =       867.773 kN-m.
           -. Pu/Pr      =   0.224  --->  O.K !
           -. Muy/Mry    =   0.224  --->  O.K !
           -. Muz/Mrz    =   0.224  --->  O.K !
           -. Mu/Mr      =   0.224  --->  O.K !
           -. Ratio      =   0.224  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       5443.53 kN.
           -. Vuz    =         83.14 kN.
           -. Muy    =       -124.40 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  32.02 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.91

           -. Vuy    =        175.71 kN.
           -. Muz    =       -263.39 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.27 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.82
```

( ). Compute shear strength of concrete.
-. Vuz = 83.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1316.95 kN.
-. phiVcz = phi * Vcz = 1185.26 kN.

-. Vuy = 175.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1275.22 kN.
-. phiVcy = phi * Vcy = 1147.70 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2163.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5831.54 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2163.49 kN.
-. phiVsz = phi*Vsz = 1947.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2142.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5873.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2142.51 kN.
-. phiVsy = phi*Vsy = 1928.26 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 194.385 kN.
-. Vr = 3075.958 kN.
-. Ratio = Vu / Vr = 0.063 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 215.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 215.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0075 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0074 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0074 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116229,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5476.88       -82.85       -49.42      -175.59      -104.91
           ------------------------------------------------------------------------------
            DL+LL+Others     5476.88       -82.85       -49.42      -175.59      -104.91
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       49.42 kN-m.
           -. End Moments (My2) =       82.85 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -49.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -49.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      104.91 kN-m.
          -. End Moments (Mz2) =      175.59 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -104.91 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -104.91 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =       220.204 kN-m.
           -. Mrz        =       467.465 kN-m.
           -. Mr         =       516.733 kN-m.
           -. Pu/Pr      =   0.224  --->  O.K !
           -. Muy/Mry    =   0.224  --->  O.K !
           -. Muz/Mrz    =   0.224  --->  O.K !
           -. Mu/Mr      =   0.224  --->  O.K !
           -. Ratio      =   0.224  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       5460.23 kN.
           -. Vuz    =         66.90 kN.
           -. Muy    =        -82.85 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.89 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.97

           -. Vuy    =        141.48 kN.
           -. Muz    =       -175.59 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.13 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 66.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1339.91 kN.
-. phiVcz = phi * Vcz = 1205.92 kN.

-. Vuy = 141.48 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1298.56 kN.
-. phiVcy = phi * Vcy = 1168.71 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2174.59 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5808.57 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2174.59 kN.
-. phiVsz = phi*Vsz = 1957.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2154.38 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5849.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2154.38 kN.
-. phiVsy = phi*Vsy = 1938.94 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 156.497 kN.
-. Vr = 3107.645 kN.
-. Ratio = Vu / Vr = 0.050 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 173.89 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 173.89 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0079 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0079 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0079 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116230,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5493.57       -49.42       -26.33      -104.91       -56.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5493.57       -49.42       -26.33      -104.91       -56.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       26.33 kN-m.
           -. End Moments (My2) =       49.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -26.33 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -26.33 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       56.00 kN-m.
          -. End Moments (Mz2) =      104.91 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -56.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -56.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       116.972 kN-m.
          -. Mrz        =       248.776 kN-m.
          -. Mr         =       274.904 kN-m.
          -. Pu/Pr      =   0.225  --->  O.K !
          -. Muy/Mry    =   0.225  --->  O.K !
          -. Muz/Mrz    =   0.225  --->  O.K !
          -. Mu/Mr      =   0.225  --->  O.K !
          -. Ratio      =   0.225  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5476.92 kN.
          -. Vuz    =         46.21 kN.
          -. Muy    =        -49.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =         97.84 kN.
          -. Muz    =       -104.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 46.21 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1361.73 kN.
-. phiVcz = phi * Vcz = 1225.56 kN.

-. Vuy = 97.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1320.78 kN.
-. phiVcy = phi * Vcy = 1188.70 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2184.87 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5786.76 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2184.87 kN.
-. phiVsz = phi*Vsz = 1966.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2165.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5827.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2165.36 kN.
-. phiVsy = phi*Vsy = 1948.82 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 108.198 kN.
-. Vr = 3137.525 kN.
-. Ratio = Vu / Vr = 0.034 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 120.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 120.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0082 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0082 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0082 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116231,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5510.25       -26.33       -11.74       -56.00       -25.02
           ------------------------------------------------------------------------------
            DL+LL+Others     5510.25       -26.33       -11.74       -56.00       -25.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       11.74 kN-m.
           -. End Moments (My2) =       26.33 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -11.74 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -11.74 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       25.02 kN-m.
          -. End Moments (Mz2) =       56.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -25.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -25.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        52.008 kN-m.
          -. Mrz        =       110.807 kN-m.
          -. Mr         =       122.405 kN-m.
          -. Pu/Pr      =   0.226  --->  O.K !
          -. Muy/Mry    =   0.226  --->  O.K !
          -. Muz/Mrz    =   0.226  --->  O.K !
          -. Mu/Mr      =   0.226  --->  O.K !
          -. Ratio      =   0.226  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5510.25 kN.
          -. Vuz    =         29.20 kN.
          -. Muy    =        -11.74 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.68 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.05

          -. Vuy    =         61.96 kN.
          -. Muz    =        -25.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96
```

( ). Compute shear strength of concrete.
-. Vuz = 29.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1376.98 kN.
-. phiVcz = phi * Vcz = 1239.28 kN.

-. Vuy = 61.96 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1336.33 kN.
-. phiVcy = phi * Vcy = 1202.70 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2191.90 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5771.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2191.90 kN.
-. phiVsz = phi*Vsz = 1972.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2172.88 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5812.16 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2172.88 kN.
-. phiVsy = phi*Vsy = 1955.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 68.502 kN.
-. Vr = 3158.290 kN.
-. Ratio = Vu / Vr = 0.022 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 76.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 76.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0086 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0086 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0086 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116232,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5526.93       -11.74        -3.76       -25.02        -8.02
           ------------------------------------------------------------------------------
            DL+LL+Others     5526.93       -11.74        -3.76       -25.02        -8.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.76 kN-m.
           -. End Moments (My2) =       11.74 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.76 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.76 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.02 kN-m.
          -. End Moments (Mz2) =       25.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        16.620 kN-m.
          -. Mrz        =        35.397 kN-m.
          -. Mr         =        39.105 kN-m.
          -. Pu/Pr      =   0.226  --->  O.K !
          -. Muy/Mry    =   0.226  --->  O.K !
          -. Muz/Mrz    =   0.226  --->  O.K !
          -. Mu/Mr      =   0.226  --->  O.K !
          -. Ratio      =   0.226  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5526.93 kN.
          -. Vuz    =         15.99 kN.
          -. Muy    =         -3.76 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.07

          -. Vuy    =         34.01 kN.
          -. Muz    =         -8.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.98
```

( ). Compute shear strength of concrete.
-. Vuz = 15.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1386.34 kN.
-. phiVcz = phi * Vcz = 1247.71 kN.

-. Vuy = 34.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1345.89 kN.
-. phiVcy = phi * Vcy = 1211.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2196.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5762.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2196.15 kN.
-. phiVsz = phi*Vsz = 1976.54 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2177.43 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5802.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2177.43 kN.
-. phiVsy = phi*Vsy = 1959.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 37.576 kN.
-. Vr = 3170.989 kN.
-. Ratio = Vu / Vr = 0.012 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 41.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 41.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0088 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0088 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0088 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116233,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5543.60        -3.76        -0.53        -8.02        -1.01
           ------------------------------------------------------------------------------
            DL+LL+Others     5543.60        -3.76        -0.53        -8.02        -1.01
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.53 kN-m.
           -. End Moments (My2) =        3.76 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.53 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.53 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.01 kN-m.
          -. End Moments (Mz2) =        8.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.01 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.01 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         2.348 kN-m.
          -. Mrz        =         4.440 kN-m.
          -. Mr         =         5.023 kN-m.
          -. Pu/Pr      =   0.227  --->  O.K !
          -. Muy/Mry    =   0.228  --->  O.K !
          -. Muz/Mrz    =   0.227  --->  O.K !
          -. Mu/Mr      =   0.228  --->  O.K !
          -. Ratio      =   0.228  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5543.60 kN.
          -. Vuz    =          6.58 kN.
          -. Muy    =         -0.53 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.08

          -. Vuy    =         14.02 kN.
          -. Muz    =         -1.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.99
```

( ). Compute shear strength of concrete.
-. Vuz = 6.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1392.69 kN.
-. phiVcz = phi * Vcz = 1253.42 kN.

-. Vuy = 14.02 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1352.37 kN.
-. phiVcy = phi * Vcy = 1217.13 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2199.01 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5755.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2199.01 kN.
-. phiVsz = phi*Vsz = 1979.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2180.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5796.12 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2180.49 kN.
-. phiVsy = phi*Vsy = 1962.44 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.485 kN.
-. Vr = 3179.571 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.21 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.21 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0089 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0089 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0089 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116234,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5560.26        -0.53         0.00        -1.01         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5560.26        -0.53         0.00        -1.01         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.53 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        1.01 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.228  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.228  --->  O.K !
          -. Ratio      =   0.228  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5560.26 kN.
          -. Vuz    =          1.07 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =          2.02 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.80 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.00
```

( ). Compute shear strength of concrete.
-. Vuz = 1.07 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1355.66 kN.
-. phiVcz = phi * Vcz = 1220.09 kN.

-. Vuy = 2.02 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1355.66 kN.
-. phiVcy = phi * Vcy = 1220.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2182.03 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5792.83 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2182.03 kN.
-. phiVsz = phi*Vsz = 1963.83 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2182.03 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5792.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2182.03 kN.
-. phiVsy = phi*Vsy = 1963.83 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 2.282 kN.
-. Vr = 3183.922 kN.
-. Ratio = Vu / Vr =7.167e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 2.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 2.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0090 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0090 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0090 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117102,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1482.97     -3148.08     -2426.77     -1574.08     -1434.75
           ---------------------------------------------------------------------------
            DL+LL+Others     1482.97     -3148.08     -2426.77     -1574.08     -1434.75
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2426.77 kN-m.
           -. End Moments (My2) =     3148.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -3148.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -3148.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1434.75 kN-m.
          -. End Moments (Mz2) =     1574.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1574.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1574.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2161.295 kN.
          -. Mry        =      4589.373 kN-m.
          -. Mrz        =      2302.874 kN-m.
          -. Mr         =      5134.742 kN-m.
          -. Pu/Pr      =   0.686  --->  O.K !
          -. Muy/Mry    =   0.686  --->  O.K !
          -. Muz/Mrz    =   0.684  --->  O.K !
          -. Mu/Mr      =   0.686  --->  O.K !
          -. Ratio      =   0.686  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1482.97 kN.
          -. Vuz    =       1447.08 kN.
          -. Muy    =      -3148.08 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.91 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.12

          -. Vuy    =        570.48 kN.
          -. Muz    =      -1574.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.40 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.02
```

( ). Compute shear strength of concrete.
-. Vuz = 1447.08 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 956.88 kN.
-. phiVcz = phi * Vcz = 861.19 kN.

-. Vuy = 570.48 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 914.30 kN.
-. phiVcy = phi * Vcy = 822.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1938.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6191.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1938.56 kN.
-. phiVsz = phi*Vsz = 1744.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1903.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6234.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1903.49 kN.
-. phiVsy = phi*Vsy = 1713.14 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1555.472 kN.
-. Vr = 2536.011 kN.
-. Ratio = Vu / Vr = 0.613 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1728.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1728.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0115 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0115 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0115 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117103,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1499.64     -2426.77     -1758.13     -1434.75     -1304.30
           ------------------------------------------------------------------------------
            DL+LL+Others     1499.64     -2426.77     -1758.13     -1434.75     -1304.30
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1758.13 kN-m.
           -. End Moments (My2) =     2426.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -2426.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -2426.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1304.30 kN-m.
          -. End Moments (Mz2) =     1434.75 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1434.75 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1434.75 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2774.548 kN.
          -. Mry        =      4458.095 kN-m.
          -. Mrz        =      2621.049 kN-m.
          -. Mr         =      5171.509 kN-m.
          -. Pu/Pr      =   0.540  --->  O.K !
          -. Muy/Mry    =   0.544  --->  O.K !
          -. Muz/Mrz    =   0.547  --->  O.K !
          -. Mu/Mr      =   0.547  --->  O.K !
          -. Ratio      =   0.547  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1499.64 kN.
          -. Vuz    =       1343.01 kN.
          -. Muy    =      -2426.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.30

          -. Vuy    =        528.48 kN.
          -. Muz    =      -1434.75 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.21
```

( ). Compute shear strength of concrete.
-. Vuz = 1343.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1040.33 kN.
-. phiVcz = phi * Vcz = 936.30 kN.

-. Vuy = 528.48 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 997.10 kN.
-. phiVcy = phi * Vcy = 897.39 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2001.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6108.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2001.06 kN.
-. phiVsz = phi*Vsz = 1800.95 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1969.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6151.38 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1969.65 kN.
-. phiVsy = phi*Vsy = 1772.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1443.246 kN.
-. Vr = 2670.082 kN.
-. Ratio = Vu / Vr = 0.541 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1603.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1603.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0092 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0092 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0092 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117104,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1516.31     -1758.13     -1144.68     -1304.30     -1185.59
           ------------------------------------------------------------------------------
            DL+LL+Others     1516.31     -1758.13     -1144.68     -1304.30     -1185.59
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1144.68 kN-m.
           -. End Moments (My2) =     1758.13 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1758.13 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1758.13 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1185.59 kN-m.
          -. End Moments (Mz2) =     1304.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1304.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1304.30 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      3641.692 kN.
          -. Mry        =      4183.490 kN-m.
          -. Mrz        =      3103.913 kN-m.
          -. Mr         =      5209.210 kN-m.
          -. Pu/Pr      =   0.416  --->  O.K !
          -. Muy/Mry    =   0.420  --->  O.K !
          -. Muz/Mrz    =   0.420  --->  O.K !
          -. Mu/Mr      =   0.420  --->  O.K !
          -. Ratio      =   0.420  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1516.31 kN.
          -. Vuz    =       1235.01 kN.
          -. Muy    =      -1758.13 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.28 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.50

          -. Vuy    =        485.13 kN.
          -. Muz    =      -1304.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41
```

( ). Compute shear strength of concrete.
-. Vuz = 1235.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1130.60 kN.
-. phiVcz = phi * Vcz = 1017.54 kN.

-. Vuy = 485.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1087.23 kN.
-. phiVcy = phi * Vcy = 978.51 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2060.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6017.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2060.72 kN.
-. phiVsz = phi*Vsz = 1854.64 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2032.99 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6061.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2032.99 kN.
-. phiVsy = phi*Vsy = 1829.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1326.873 kN.
-. Vr = 2808.201 kN.
-. Ratio = Vu / Vr = 0.472 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1474.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1474.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0070 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0071 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0071 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117105,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1604.78      -777.51      -511.21     -1666.66     -1685.88
           ------------------------------------------------------------------------------
            DL+LL+Others     1604.78      -777.51      -511.21     -1666.66     -1685.88
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      511.21 kN-m.
           -. End Moments (My2) =      777.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -777.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -777.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1666.66 kN-m.
          -. End Moments (Mz2) =     1685.88 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1666.66 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1666.66 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4570.333 kN.
          -. Mry        =      2212.422 kN-m.
          -. Mrz        =      4744.340 kN-m.
          -. Mr         =      5234.842 kN-m.
          -. Pu/Pr      =   0.351  --->  O.K !
          -. Muy/Mry    =   0.351  --->  O.K !
          -. Muz/Mrz    =   0.351  --->  O.K !
          -. Mu/Mr      =   0.351  --->  O.K !
          -. Ratio      =   0.351  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1532.98 kN.
          -. Vuz    =       1124.14 kN.
          -. Muy    =      -1144.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71

          -. Vuy    =        440.89 kN.
          -. Muz    =      -1185.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.90 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61
```

( ). Compute shear strength of concrete.
-. Vuz = 1124.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1224.14 kN.
-. phiVcz = phi * Vcz = 1101.72 kN.

-. Vuy = 440.89 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1181.27 kN.
-. phiVcy = phi * Vcy = 1063.14 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2115.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5924.35 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2115.33 kN.
-. phiVsz = phi*Vsz = 1903.80 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2091.12 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5967.22 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2091.12 kN.
-. phiVsy = phi*Vsy = 1882.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1207.504 kN.
-. Vr = 2945.151 kN.
-. Ratio = Vu / Vr = 0.410 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1341.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1341.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117106,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1621.45      -511.21      -318.34     -1685.88     -1691.16
           ------------------------------------------------------------------------------
            DL+LL+Others     1621.45      -511.21      -318.34     -1685.88     -1691.16
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      318.34 kN-m.
           -. End Moments (My2) =      511.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -511.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -511.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1685.88 kN-m.
          -. End Moments (Mz2) =     1691.16 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1685.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1685.88 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4798.719 kN.
          -. Mry        =      1515.029 kN-m.
          -. Mrz        =      4997.031 kN-m.
          -. Mr         =      5221.650 kN-m.
          -. Pu/Pr      =   0.338  --->  O.K !
          -. Muy/Mry    =   0.337  --->  O.K !
          -. Muz/Mrz    =   0.337  --->  O.K !
          -. Mu/Mr      =   0.338  --->  O.K !
          -. Ratio      =   0.338  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1549.65 kN.
          -. Vuz    =       1011.57 kN.
          -. Muy    =       -589.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90

          -. Vuy    =        396.23 kN.
          -. Muz    =      -1082.13 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.30 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.81
```

( ). Compute shear strength of concrete.
-. Vuz = 1011.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1311.53 kN.
-. phiVcz = phi * Vcz = 1180.38 kN.

-. Vuy = 396.23 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1269.72 kN.
-. phiVcy = phi * Vcy = 1142.74 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2160.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5836.95 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2160.82 kN.
-. phiVsz = phi*Vsz = 1944.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2139.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5878.77 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2139.67 kN.
-. phiVsy = phi*Vsy = 1925.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1086.398 kN.
-. Vr = 3068.444 kN.
-. Ratio = Vu / Vr = 0.354 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1207.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1207.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117107,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1654.77      -318.34      -379.29     -1691.16     -1682.70
           ------------------------------------------------------------------------------
            DL+LL+Others     1654.77      -318.34      -379.29     -1691.16     -1682.70
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      318.34 kN-m.
           -. End Moments (My2) =      379.29 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -379.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -379.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1682.70 kN-m.
          -. End Moments (Mz2) =     1691.16 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1682.70 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1682.70 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4985.443 kN.
          -. Mry        =      1143.309 kN-m.
          -. Mrz        =      5099.853 kN-m.
          -. Mr         =      5226.438 kN-m.
          -. Pu/Pr      =   0.332  --->  O.K !
          -. Muy/Mry    =   0.332  --->  O.K !
          -. Muz/Mrz    =   0.330  --->  O.K !
          -. Mu/Mr      =   0.332  --->  O.K !
          -. Ratio      =   0.332  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1582.97 kN.
          -. Vuz    =        898.55 kN.
          -. Muy    =       -573.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.81 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =        351.69 kN.
          -. Muz    =       -934.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 898.55 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1354.30 kN.
-. phiVcz = phi * Vcz = 1218.87 kN.

-. Vuy = 351.69 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1313.21 kN.
-. phiVcy = phi * Vcy = 1181.89 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2181.40 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5794.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2181.40 kN.
-. phiVsz = phi*Vsz = 1963.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2161.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5835.28 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2161.65 kN.
-. phiVsy = phi*Vsy = 1945.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 964.918 kN.
-. Vr = 3127.371 kN.
-. Ratio = Vu / Vr = 0.309 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1072.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1072.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117108,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1654.79      -379.29      -469.25     -1682.70     -1660.89
           ------------------------------------------------------------------------------
            DL+LL+Others     1654.79      -379.29      -469.25     -1682.70     -1660.89
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      379.29 kN-m.
           -. End Moments (My2) =      469.25 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -379.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -379.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1660.89 kN-m.
          -. End Moments (Mz2) =     1682.70 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1682.70 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1682.70 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4985.443 kN.
          -. Mry        =      1143.309 kN-m.
          -. Mrz        =      5099.853 kN-m.
          -. Mr         =      5226.438 kN-m.
          -. Pu/Pr      =   0.332  --->  O.K !
          -. Muy/Mry    =   0.332  --->  O.K !
          -. Muz/Mrz    =   0.330  --->  O.K !
          -. Mu/Mr      =   0.332  --->  O.K !
          -. Ratio      =   0.332  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1599.64 kN.
          -. Vuz    =        786.34 kN.
          -. Muy    =       -911.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96

          -. Vuy    =        307.83 kN.
          -. Muz    =       -885.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 786.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1339.31 kN.
-. phiVcz = phi * Vcz = 1205.38 kN.

-. Vuy = 307.83 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1297.94 kN.
-. phiVcy = phi * Vcy = 1168.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2174.30 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5809.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2174.30 kN.
-. phiVsz = phi*Vsz = 1956.87 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2154.07 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5850.54 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2154.07 kN.
-. phiVsy = phi*Vsy = 1938.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 844.447 kN.
-. Vr = 3106.811 kN.
-. Ratio = Vu / Vr = 0.272 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 938.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 938.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117109,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1688.11      -469.25      -573.84     -1660.89     -1624.76
           ------------------------------------------------------------------------------
            DL+LL+Others     1688.11      -469.25      -573.84     -1660.89     -1624.76
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      469.25 kN-m.
           -. End Moments (My2) =      573.84 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -573.84 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -573.84 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1624.76 kN-m.
          -. End Moments (Mz2) =     1660.89 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1624.76 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1624.76 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      5086.082 kN.
          -. Mry        =      1738.794 kN-m.
          -. Mrz        =      4926.652 kN-m.
          -. Mr         =      5224.491 kN-m.
          -. Pu/Pr      =   0.332  --->  O.K !
          -. Muy/Mry    =   0.330  --->  O.K !
          -. Muz/Mrz    =   0.330  --->  O.K !
          -. Mu/Mr      =   0.332  --->  O.K !
          -. Ratio      =   0.332  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1616.31 kN.
          -. Vuz    =        676.27 kN.
          -. Muy    =      -1209.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.92

          -. Vuy    =        265.45 kN.
          -. Muz    =       -845.36 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.83
```

( ). Compute shear strength of concrete.
-. Vuz = 676.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1318.63 kN.
-. phiVcz = phi * Vcz = 1186.77 kN.

-. Vuy = 265.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1276.93 kN.
-. phiVcy = phi * Vcy = 1149.23 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2164.31 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5829.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2164.31 kN.
-. phiVsz = phi*Vsz = 1947.88 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2143.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5871.56 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2143.39 kN.
-. phiVsy = phi*Vsy = 1929.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 726.498 kN.
-. Vr = 3078.287 kN.
-. Ratio = Vu / Vr = 0.236 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 807.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 807.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                  Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117110,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1688.13      -573.84      -676.03     -1624.76     -1574.23
           ------------------------------------------------------------------------------
            DL+LL+Others     1688.13      -573.84      -676.03     -1624.76     -1574.23
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      573.84 kN-m.
           -. End Moments (My2) =      676.03 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -573.84 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -573.84 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1574.23 kN-m.
          -. End Moments (Mz2) =     1624.76 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1624.76 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1624.76 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      5086.082 kN.
          -. Mry        =      1738.794 kN-m.
          -. Mrz        =      4926.652 kN-m.
          -. Mr         =      5224.491 kN-m.
          -. Pu/Pr      =   0.332  --->  O.K !
          -. Muy/Mry    =   0.330  --->  O.K !
          -. Muz/Mrz    =   0.330  --->  O.K !
          -. Mu/Mr      =   0.332  --->  O.K !
          -. Ratio      =   0.332  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1632.97 kN.
          -. Vuz    =        569.66 kN.
          -. Muy    =      -1463.46 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.12 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        227.53 kN.
          -. Muz    =       -807.75 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.78
```

( ). Compute shear strength of concrete.
-. Vuz = 569.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1299.49 kN.
-. phiVcz = phi * Vcz = 1169.54 kN.

-. Vuy = 227.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1257.49 kN.
-. phiVcy = phi * Vcy = 1131.74 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2154.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5849.00 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2154.84 kN.
-. phiVsz = phi*Vsz = 1939.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2133.28 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5890.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2133.28 kN.
-. phiVsy = phi*Vsy = 1919.95 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 613.424 kN.
-. Vr = 3051.691 kN.
-. Ratio = Vu / Vr = 0.201 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 681.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 681.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117111,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            668.57      1434.31      1655.49       708.52       750.43
           ------------------------------------------------------------------------------
            DL+LL+Others      668.57      1434.31      1655.49       708.52       750.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1434.31 kN-m.
           -. End Moments (My2) =     1655.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1655.49 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1655.49 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      708.52 kN-m.
          -. End Moments (Mz2) =      750.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      750.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      750.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1887.485 kN.
          -. Mry        =      4665.699 kN-m.
          -. Mrz        =      2113.630 kN-m.
          -. Mr         =      5122.126 kN-m.
          -. Pu/Pr      =   0.354  --->  O.K !
          -. Muy/Mry    =   0.355  --->  O.K !
          -. Muz/Mrz    =   0.355  --->  O.K !
          -. Mu/Mr      =   0.355  --->  O.K !
          -. Ratio      =   0.355  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1649.64 kN.
          -. Vuz    =        467.86 kN.
          -. Muy    =      -1674.99 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.22 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        205.72 kN.
          -. Muz    =       -769.26 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 467.86 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1283.49 kN.
-. phiVcz = phi * Vcz = 1155.14 kN.

-. Vuy = 205.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1241.28 kN.
-. phiVcy = phi * Vcy = 1117.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2146.76 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5864.99 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2146.76 kN.
-. phiVsz = phi*Vsz = 1932.08 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2124.64 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5907.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2124.64 kN.
-. phiVsy = phi*Vsy = 1912.18 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 511.090 kN.
-. Vr = 3029.329 kN.
-. Ratio = Vu / Vr = 0.169 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 567.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 567.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117112,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            680.55      1655.49      1835.48       750.43       790.15
           ------------------------------------------------------------------------------
            DL+LL+Others      680.55      1655.49      1835.48       750.43       790.15
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1655.49 kN-m.
           -. End Moments (My2) =     1835.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1835.48 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1835.48 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      750.43 kN-m.
          -. End Moments (Mz2) =      790.15 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      790.15 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      790.15 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1740.522 kN.
          -. Mry        =      4698.622 kN-m.
          -. Mrz        =      2018.414 kN-m.
          -. Mr         =      5113.810 kN-m.
          -. Pu/Pr      =   0.391  --->  O.K !
          -. Muy/Mry    =   0.391  --->  O.K !
          -. Muz/Mrz    =   0.391  --->  O.K !
          -. Mu/Mr      =   0.391  --->  O.K !
          -. Ratio      =   0.391  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1666.30 kN.
          -. Vuz    =        372.15 kN.
          -. Muy    =      -1846.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81

          -. Vuy    =        190.56 kN.
          -. Muz    =       -737.36 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.57 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.72
```

( ). Compute shear strength of concrete.
-. Vuz = 372.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1271.10 kN.
-. phiVcz = phi * Vcz = 1143.99 kN.

-. Vuy = 190.56 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1228.72 kN.
-. phiVcy = phi * Vcy = 1105.85 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2140.38 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5877.39 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2140.38 kN.
-. phiVsz = phi*Vsz = 1926.35 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2117.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5919.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2117.84 kN.
-. phiVsy = phi*Vsy = 1906.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 418.104 kN.
-. Vr = 3011.909 kN.
-. Ratio = Vu / Vr = 0.139 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 464.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 464.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117113,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            692.54      1835.48      1973.22       790.15       823.36
           ---------------------------------------------------------------------------
            DL+LL+Others      692.54      1835.48      1973.22       790.15       823.36
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1835.48 kN-m.
           -. End Moments (My2) =     1973.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1973.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1973.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      790.15 kN-m.
          -. End Moments (Mz2) =      823.36 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      823.36 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      823.36 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1650.881 kN.
          -. Mry        =      4713.635 kN-m.
          -. Mrz        =      1964.656 kN-m.
          -. Mr         =      5106.684 kN-m.
          -. Pu/Pr      =   0.419  --->  O.K !
          -. Muy/Mry    =   0.419  --->  O.K !
          -. Muz/Mrz    =   0.419  --->  O.K !
          -. Mu/Mr      =   0.419  --->  O.K !
          -. Ratio      =   0.419  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1682.97 kN.
          -. Vuz    =        283.74 kN.
          -. Muy    =      -1975.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.34 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =        176.40 kN.
          -. Muz    =       -707.44 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.70
```

( ). Compute shear strength of concrete.
-. Vuz = 283.74 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1263.37 kN.
-. phiVcz = phi * Vcz = 1137.03 kN.

-. Vuy = 176.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1220.90 kN.
-. phiVcy = phi * Vcy = 1098.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2136.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5885.12 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2136.36 kN.
-. phiVsz = phi*Vsz = 1922.72 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2113.55 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5927.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2113.55 kN.
-. phiVsy = phi*Vsy = 1902.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 334.106 kN.
-. Vr = 3001.005 kN.
-. Ratio = Vu / Vr = 0.111 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 371.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 371.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117114,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            704.52      1973.22      2053.52       823.36       844.22
           ---------------------------------------------------------------------------
            DL+LL+Others      704.52      1973.22      2053.52       823.36       844.22
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1973.22 kN-m.
           -. End Moments (My2) =     2053.52 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2053.52 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2053.52 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      823.36 kN-m.
          -. End Moments (Mz2) =      844.22 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      844.22 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      844.22 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1628.444 kN.
          -. Mry        =      4721.987 kN-m.
          -. Mrz        =      1939.782 kN-m.
          -. Mr         =      5104.891 kN-m.
          -. Pu/Pr      =   0.433  --->  O.K !
          -. Muy/Mry    =   0.435  --->  O.K !
          -. Muz/Mrz    =   0.435  --->  O.K !
          -. Mu/Mr      =   0.435  --->  O.K !
          -. Ratio      =   0.435  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1754.80 kN.
          -. Vuz    =        110.00 kN.
          -. Muy    =       -914.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.81 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =        216.78 kN.
          -. Muz    =      -1370.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 110.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1353.91 kN.
-. phiVcz = phi * Vcz = 1218.52 kN.

-. Vuy = 216.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1312.81 kN.
-. phiVcy = phi * Vcy = 1181.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2181.21 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5794.58 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2181.21 kN.
-. phiVsz = phi*Vsz = 1963.09 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2161.46 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5835.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2161.46 kN.
-. phiVsy = phi*Vsy = 1945.31 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 243.092 kN.
-. Vr = 3126.840 kN.
-. Ratio = Vu / Vr = 0.078 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 270.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 270.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117115,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            716.50      2053.52      2068.34       844.22       841.55
           ------------------------------------------------------------------------------
            DL+LL+Others      716.50      2053.52      2068.34       844.22       841.55
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2053.52 kN-m.
           -. End Moments (My2) =     2068.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2068.34 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2068.34 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      841.55 kN-m.
          -. End Moments (Mz2) =      844.22 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      841.55 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      841.55 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1628.717 kN.
          -. Mry        =      4728.873 kN-m.
          -. Mrz        =      1922.991 kN-m.
          -. Mr         =      5104.913 kN-m.
          -. Pu/Pr      =   0.440  --->  O.K !
          -. Muy/Mry    =   0.437  --->  O.K !
          -. Muz/Mrz    =   0.438  --->  O.K !
          -. Mu/Mr      =   0.440  --->  O.K !
          -. Ratio      =   0.440  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1771.47 kN.
          -. Vuz    =         49.28 kN.
          -. Muy    =       -953.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.02

          -. Vuy    =        231.27 kN.
          -. Muz    =      -1289.29 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.99 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 49.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1362.19 kN.
-. phiVcz = phi * Vcz = 1225.97 kN.

-. Vuy = 231.27 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1321.25 kN.
-. phiVcy = phi * Vcy = 1189.12 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2185.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5786.30 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2185.08 kN.
-. phiVsz = phi*Vsz = 1966.57 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2165.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5827.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2165.59 kN.
-. phiVsy = phi*Vsy = 1949.03 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 236.458 kN.
-. Vr = 3138.155 kN.
-. Ratio = Vu / Vr = 0.075 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 262.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 262.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117116,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            716.49      2068.34      2026.90       841.55       818.23
           ---------------------------------------------------------------------------
            DL+LL+Others      716.49      2068.34      2026.90       841.55       818.23
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2026.90 kN-m.
           -. End Moments (My2) =     2068.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2068.34 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2068.34 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      818.23 kN-m.
          -. End Moments (Mz2) =      841.55 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      841.55 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      841.55 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1628.717 kN.
          -. Mry        =      4728.873 kN-m.
          -. Mrz        =      1922.991 kN-m.
          -. Mr         =      5104.913 kN-m.
          -. Pu/Pr      =   0.440  --->  O.K !
          -. Muy/Mry    =   0.437  --->  O.K !
          -. Muz/Mrz    =   0.438  --->  O.K !
          -. Mu/Mr      =   0.440  --->  O.K !
          -. Ratio      =   0.440  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1788.13 kN.
          -. Vuz    =         59.35 kN.
          -. Muy    =       -962.54 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        240.95 kN.
          -. Muz    =      -1192.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 59.35 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1372.83 kN.
-. phiVcz = phi * Vcz = 1235.54 kN.

-. Vuy = 240.95 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1332.09 kN.
-. phiVcy = phi * Vcy = 1198.88 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2189.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5775.66 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2189.99 kN.
-. phiVsz = phi*Vsz = 1970.99 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2170.85 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5816.39 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2170.85 kN.
-. phiVsy = phi*Vsy = 1953.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 248.153 kN.
-. Vr = 3152.645 kN.
-. Ratio = Vu / Vr = 0.079 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 275.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 275.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117117,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            728.48      2026.90      1939.54       818.23       778.08
           ------------------------------------------------------------------------------
            DL+LL+Others      728.48      2026.90      1939.54       818.23       778.08
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1939.54 kN-m.
           -. End Moments (My2) =     2026.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2026.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2026.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      778.08 kN-m.
          -. End Moments (Mz2) =      818.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      818.23 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      818.23 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1720.433 kN.
          -. Mry        =      4740.848 kN-m.
          -. Mrz        =      1912.893 kN-m.
          -. Mr         =      5112.221 kN-m.
          -. Pu/Pr      =   0.423  --->  O.K !
          -. Muy/Mry    =   0.428  --->  O.K !
          -. Muz/Mrz    =   0.428  --->  O.K !
          -. Mu/Mr      =   0.428  --->  O.K !
          -. Ratio      =   0.428  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1804.80 kN.
          -. Vuz    =         87.98 kN.
          -. Muy    =       -945.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.07

          -. Vuy    =        245.07 kN.
          -. Muz    =      -1084.46 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.98
```

( ). Compute shear strength of concrete.
-. Vuz = 87.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1388.23 kN.
-. phiVcz = phi * Vcz = 1249.41 kN.

-. Vuy = 245.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1347.81 kN.
-. phiVcy = phi * Vcy = 1213.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2197.00 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5760.26 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2197.00 kN.
-. phiVsz = phi*Vsz = 1977.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2178.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5800.67 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2178.34 kN.
-. phiVsy = phi*Vsy = 1960.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 260.382 kN.
-. Vr = 3173.540 kN.
-. Ratio = Vu / Vr = 0.082 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 289.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 289.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117118,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            740.46      1939.54      1816.58       778.08       725.00
           ---------------------------------------------------------------------------
            DL+LL+Others      740.46      1939.54      1816.58       778.08       725.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1816.58 kN-m.
           -. End Moments (My2) =     1939.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1939.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1939.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      725.00 kN-m.
          -. End Moments (Mz2) =      778.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      778.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      778.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1811.197 kN.
          -. Mry        =      4751.590 kN-m.
          -. Mrz        =      1905.422 kN-m.
          -. Mr         =      5119.399 kN-m.
          -. Pu/Pr      =   0.409  --->  O.K !
          -. Muy/Mry    =   0.408  --->  O.K !
          -. Muz/Mrz    =   0.408  --->  O.K !
          -. Mu/Mr      =   0.409  --->  O.K !
          -. Ratio      =   0.409  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1749.64 kN.
          -. Vuz    =        251.79 kN.
          -. Muy    =      -1922.82 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        123.80 kN.
          -. Muz    =       -535.09 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 251.79 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1284.06 kN.
-. phiVcz = phi * Vcz = 1155.66 kN.

-. Vuy = 123.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1241.85 kN.
-. phiVcy = phi * Vcy = 1117.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2147.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5864.42 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2147.05 kN.
-. phiVsz = phi*Vsz = 1932.34 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2124.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5906.63 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2124.96 kN.
-. phiVsy = phi*Vsy = 1912.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 280.581 kN.
-. Vr = 3030.129 kN.
-. Ratio = Vu / Vr = 0.093 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 311.76 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 311.76 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117119,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            752.45      1816.58      1668.17       725.00       662.84
           ---------------------------------------------------------------------------
            DL+LL+Others      752.45      1816.58      1668.17       725.00       662.84
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1668.17 kN-m.
           -. End Moments (My2) =     1816.58 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1816.58 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1816.58 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      662.84 kN-m.
          -. End Moments (Mz2) =      725.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      725.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      725.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1989.988 kN.
          -. Mry        =      4767.903 kN-m.
          -. Mrz        =      1902.245 kN-m.
          -. Mr         =      5133.365 kN-m.
          -. Pu/Pr      =   0.378  --->  O.K !
          -. Muy/Mry    =   0.381  --->  O.K !
          -. Muz/Mrz    =   0.381  --->  O.K !
          -. Mu/Mr      =   0.381  --->  O.K !
          -. Ratio      =   0.381  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1766.30 kN.
          -. Vuz    =        299.58 kN.
          -. Muy    =      -1798.04 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.12 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        120.22 kN.
          -. Muz    =       -478.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.79
```

( ). Compute shear strength of concrete.
-. Vuz = 299.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1300.30 kN.
-. phiVcz = phi * Vcz = 1170.27 kN.

-. Vuy = 120.22 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1258.32 kN.
-. phiVcy = phi * Vcy = 1132.49 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2155.25 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5848.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2155.25 kN.
-. phiVsz = phi*Vsz = 1939.72 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2133.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5890.17 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2133.71 kN.
-. phiVsy = phi*Vsy = 1920.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 322.799 kN.
-. Vr = 3052.824 kN.
-. Ratio = Vu / Vr = 0.106 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 358.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 358.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117120,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            764.43      1668.17      1503.87       662.84       595.27
           ------------------------------------------------------------------------------
            DL+LL+Others      764.43      1668.17      1503.87       662.84       595.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1503.87 kN-m.
           -. End Moments (My2) =     1668.17 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1668.17 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1668.17 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      595.27 kN-m.
          -. End Moments (Mz2) =      662.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      662.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      662.84 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =      2171.613 kN.
           -. Mry        =      4782.128 kN-m.
           -. Mrz        =      1900.614 kN-m.
           -. Mr         =      5145.977 kN-m.
           -. Pu/Pr      =   0.352  --->  O.K !
           -. Muy/Mry    =   0.349  --->  O.K !
           -. Muz/Mrz    =   0.349  --->  O.K !
           -. Mu/Mr      =   0.352  --->  O.K !
           -. Ratio      =   0.352  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       1782.96 kN.
           -. Vuz    =        329.34 kN.
           -. Muy    =      -1648.74 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.98 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.93

           -. Vuy    =        115.94 kN.
           -. Muz    =       -420.24 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.23 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 329.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1323.88 kN.
-. phiVcz = phi * Vcz = 1191.49 kN.

-. Vuy = 115.94 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1282.26 kN.
-. phiVcy = phi * Vcy = 1154.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2166.87 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5824.60 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2166.87 kN.
-. phiVsz = phi*Vsz = 1950.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2146.13 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5866.23 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2146.13 kN.
-. phiVsy = phi*Vsy = 1931.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 349.149 kN.
-. Vr = 3085.550 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 387.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 387.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117121,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            776.42      1503.87      1332.42       595.27       525.62
           ---------------------------------------------------------------------------
            DL+LL+Others      776.42      1503.87      1332.42       595.27       525.62
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1332.42 kN-m.
           -. End Moments (My2) =     1503.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1503.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1503.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      525.62 kN-m.
          -. End Moments (Mz2) =      595.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      595.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      595.27 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2486.897 kN.
          -. Mry        =      4798.286 kN-m.
          -. Mrz        =      1899.248 kN-m.
          -. Mr         =      5160.493 kN-m.
          -. Pu/Pr      =   0.312  --->  O.K !
          -. Muy/Mry    =   0.313  --->  O.K !
          -. Muz/Mrz    =   0.313  --->  O.K !
          -. Mu/Mr      =   0.313  --->  O.K !
          -. Ratio      =   0.313  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        776.42 kN.
          -. Vuz    =        343.15 kN.
          -. Muy    =       1503.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.06

          -. Vuy    =        140.59 kN.
          -. Muz    =        595.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.06
```

( ). Compute shear strength of concrete.
-. Vuz = 343.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1384.29 kN.
-. phiVcz = phi * Vcz = 1245.86 kN.

-. Vuy = 140.59 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1384.29 kN.
-. phiVcy = phi * Vcy = 1245.86 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2195.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5764.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2195.22 kN.
-. phiVsz = phi*Vsz = 1975.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2195.22 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5764.19 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2195.22 kN.
-. phiVsy = phi*Vsy = 1975.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 370.837 kN.
-. Vr = 3221.563 kN.
-. Ratio = Vu / Vr = 0.115 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 412.04 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 412.04 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117122,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            788.40      1332.42      1161.63       525.62       456.86
           ---------------------------------------------------------------------------
            DL+LL+Others      788.40      1332.42      1161.63       525.62       456.86
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1161.63 kN-m.
           -. End Moments (My2) =     1332.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1332.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1332.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      456.86 kN-m.
          -. End Moments (Mz2) =      525.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      525.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      525.62 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2862.674 kN.
          -. Mry        =      4816.072 kN-m.
          -. Mrz        =      1899.625 kN-m.
          -. Mr         =      5177.174 kN-m.
          -. Pu/Pr      =   0.275  --->  O.K !
          -. Muy/Mry    =   0.277  --->  O.K !
          -. Muz/Mrz    =   0.277  --->  O.K !
          -. Mu/Mr      =   0.277  --->  O.K !
          -. Ratio      =   0.277  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        788.40 kN.
          -. Vuz    =        341.75 kN.
          -. Muy    =       1332.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.16

          -. Vuy    =        138.44 kN.
          -. Muz    =        525.62 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.16
```

( ). Compute shear strength of concrete.
-. Vuz = 341.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1425.50 kN.
-. phiVcz = phi * Vcz = 1282.95 kN.

-. Vuy = 138.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1425.50 kN.
-. phiVcy = phi * Vcy = 1282.95 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2213.46 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5722.99 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2213.46 kN.
-. phiVsz = phi*Vsz = 1992.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2213.46 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5722.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2213.46 kN.
-. phiVsy = phi*Vsy = 1992.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 368.728 kN.
-. Vr = 3275.061 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 409.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 409.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117123,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            800.39      1161.63       998.20       456.86       391.55
           ------------------------------------------------------------------------------
            DL+LL+Others      800.39      1161.63       998.20       456.86       391.55
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      998.20 kN-m.
           -. End Moments (My2) =     1161.63 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1161.63 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1161.63 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      391.55 kN-m.
          -. End Moments (Mz2) =      456.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      456.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      456.86 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      3342.643 kN.
          -. Mry        =      4836.779 kN-m.
          -. Mrz        =      1902.105 kN-m.
          -. Mr         =      5197.349 kN-m.
          -. Pu/Pr      =   0.239  --->  O.K !
          -. Muy/Mry    =   0.240  --->  O.K !
          -. Muz/Mrz    =   0.240  --->  O.K !
          -. Mu/Mr      =   0.240  --->  O.K !
          -. Ratio      =   0.240  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        800.39 kN.
          -. Vuz    =        326.95 kN.
          -. Muy    =       1161.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.26

          -. Vuy    =        131.27 kN.
          -. Muz    =        456.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.26
```

( ). Compute shear strength of concrete.
-. Vuz = 326.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1472.07 kN.
-. phiVcz = phi * Vcz = 1324.86 kN.

-. Vuy = 131.27 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1472.07 kN.
-. phiVcy = phi * Vcy = 1324.86 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2233.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5676.42 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2233.08 kN.
-. phiVsz = phi*Vsz = 2009.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2233.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5676.42 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2233.08 kN.
-. phiVsy = phi*Vsy = 2009.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 352.319 kN.
-. Vr = 3334.639 kN.
-. Ratio = Vu / Vr = 0.106 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 391.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 391.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117124,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            812.38       998.20       847.11       391.55       331.53
           ------------------------------------------------------------------------------
            DL+LL+Others      812.38       998.20       847.11       391.55       331.53
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      847.11 kN-m.
           -. End Moments (My2) =      998.20 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      998.20 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      998.20 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      331.53 kN-m.
          -. End Moments (Mz2) =      391.55 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      391.55 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      391.55 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      3973.628 kN.
          -. Mry        =      4860.978 kN-m.
          -. Mrz        =      1906.892 kN-m.
          -. Mr         =      5221.623 kN-m.
          -. Pu/Pr      =   0.204  --->  O.K !
          -. Muy/Mry    =   0.205  --->  O.K !
          -. Muz/Mrz    =   0.205  --->  O.K !
          -. Mu/Mr      =   0.205  --->  O.K !
          -. Ratio      =   0.205  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        812.38 kN.
          -. Vuz    =        302.26 kN.
          -. Muy    =        998.20 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.37

          -. Vuy    =        120.50 kN.
          -. Muz    =        391.55 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.98 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.37
```

( ). Compute shear strength of concrete.
-. Vuz = 302.26 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1522.04 kN.
-. phiVcz = phi * Vcz = 1369.84 kN.

-. Vuy = 120.50 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1522.04 kN.
-. phiVcy = phi * Vcy = 1369.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2253.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5626.44 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2253.07 kN.
-. phiVsz = phi*Vsz = 2027.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2253.07 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5626.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2253.07 kN.
-. phiVsy = phi*Vsy = 2027.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 325.391 kN.
-. Vr = 3397.599 kN.
-. Ratio = Vu / Vr = 0.096 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 361.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 361.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117125,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1866.27      -832.18      -694.50      -174.72      -140.40
           ------------------------------------------------------------------------------
            DL+LL+Others     1866.27      -832.18      -694.50      -174.72      -140.40
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      694.50 kN-m.
           -. End Moments (My2) =      832.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -832.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -832.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      140.40 kN-m.
          -. End Moments (Mz2) =      174.72 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -174.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -174.72 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10475.847 kN.
          -. Mry        =      4690.878 kN-m.
          -. Mrz        =       980.643 kN-m.
          -. Mr         =      4792.285 kN-m.
          -. Pu/Pr      =   0.178  --->  O.K !
          -. Muy/Mry    =   0.177  --->  O.K !
          -. Muz/Mrz    =   0.178  --->  O.K !
          -. Mu/Mr      =   0.178  --->  O.K !
          -. Ratio      =   0.178  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        824.36 kN.
          -. Vuz    =        278.81 kN.
          -. Muy    =        847.11 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.77 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.48

          -. Vuy    =        110.65 kN.
          -. Muz    =        331.53 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.48
```

( ). Compute shear strength of concrete.
-. Vuz = 278.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1571.35 kN.
-. phiVcz = phi * Vcz = 1414.21 kN.

-. Vuy = 110.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1571.35 kN.
-. phiVcy = phi * Vcy = 1414.21 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2271.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5577.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2271.77 kN.
-. phiVsz = phi*Vsz = 2044.59 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2271.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5577.14 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2271.77 kN.
-. phiVsy = phi*Vsy = 2044.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 299.969 kN.
-. Vr = 3458.802 kN.
-. Ratio = Vu / Vr = 0.087 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 333.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 333.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117126,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1882.93      -694.50      -570.41      -140.40      -110.82
           ---------------------------------------------------------------------------
            DL+LL+Others     1882.93      -694.50      -570.41      -140.40      -110.82
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      570.41 kN-m.
           -. End Moments (My2) =      694.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -694.50 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -694.50 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      110.82 kN-m.
          -. End Moments (Mz2) =      140.40 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -140.40 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -140.40 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12202.905 kN.
          -. Mry        =      4530.674 kN-m.
          -. Mrz        =       924.338 kN-m.
          -. Mr         =      4624.003 kN-m.
          -. Pu/Pr      =   0.154  --->  O.K !
          -. Muy/Mry    =   0.153  --->  O.K !
          -. Muz/Mrz    =   0.152  --->  O.K !
          -. Mu/Mr      =   0.154  --->  O.K !
          -. Ratio      =   0.154  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        836.35 kN.
          -. Vuz    =        251.68 kN.
          -. Muy    =        707.73 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.59

          -. Vuy    =         99.47 kN.
          -. Muz    =        276.40 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.59
```

( ). Compute shear strength of concrete.
-. Vuz = 251.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1621.13 kN.
-. phiVcz = phi * Vcz = 1459.02 kN.

-. Vuy = 99.47 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1621.13 kN.
-. phiVcy = phi * Vcy = 1459.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2289.71 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5527.35 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2289.71 kN.
-. phiVsz = phi*Vsz = 2060.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2289.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5527.35 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2289.71 kN.
-. phiVsy = phi*Vsy = 2060.74 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 270.623 kN.
-. Vr = 3519.761 kN.
-. Ratio = Vu / Vr = 0.077 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 300.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 300.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117127,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1899.59      -570.41      -460.92      -110.82       -85.94
           ------------------------------------------------------------------------------
            DL+LL+Others     1899.59      -570.41      -460.92      -110.82       -85.94
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      460.92 kN-m.
           -. End Moments (My2) =      570.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -570.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -570.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       85.94 kN-m.
          -. End Moments (Mz2) =      110.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -110.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -110.82 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14342.432 kN.
          -. Mry        =      4296.234 kN-m.
          -. Mrz        =       828.864 kN-m.
          -. Mr         =      4375.459 kN-m.
          -. Pu/Pr      =   0.132  --->  O.K !
          -. Muy/Mry    =   0.133  --->  O.K !
          -. Muz/Mrz    =   0.134  --->  O.K !
          -. Mu/Mr      =   0.134  --->  O.K !
          -. Ratio      =   0.134  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        848.34 kN.
          -. Vuz    =        222.37 kN.
          -. Muy    =        581.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.70

          -. Vuy    =         87.55 kN.
          -. Muz    =        226.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.70
```

( ). Compute shear strength of concrete.
-. Vuz = 222.37 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1670.11 kN.
-. phiVcz = phi * Vcz = 1503.10 kN.

-. Vuy = 87.55 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1670.11 kN.
-. phiVcy = phi * Vcy = 1503.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2306.51 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5478.38 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2306.51 kN.
-. phiVsz = phi*Vsz = 2075.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2306.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5478.38 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2306.51 kN.
-. phiVsy = phi*Vsy = 2075.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 238.988 kN.
-. Vr = 3578.952 kN.
-. Ratio = Vu / Vr = 0.067 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 265.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 265.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117128,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1916.25      -460.92      -365.55       -85.94       -65.31
           ------------------------------------------------------------------------------
            DL+LL+Others     1916.25      -460.92      -365.55       -85.94       -65.31
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      365.55 kN-m.
           -. End Moments (My2) =      460.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -460.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -460.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       65.31 kN-m.
          -. End Moments (Mz2) =       85.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -85.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -85.94 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     16495.971 kN.
          -. Mry        =      4001.226 kN-m.
          -. Mrz        =       750.073 kN-m.
          -. Mr         =      4070.924 kN-m.
          -. Pu/Pr      =   0.116  --->  O.K !
          -. Muy/Mry    =   0.115  --->  O.K !
          -. Muz/Mrz    =   0.115  --->  O.K !
          -. Mu/Mr      =   0.116  --->  O.K !
          -. Ratio      =   0.116  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        860.33 kN.
          -. Vuz    =        194.00 kN.
          -. Muy    =        470.74 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.80

          -. Vuy    =         76.10 kN.
          -. Muz    =        183.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.80
```

( ). Compute shear strength of concrete.
-. Vuz = 194.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1716.46 kN.
-. phiVcz = phi * Vcz = 1544.81 kN.

-. Vuy = 76.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1716.46 kN.
-. phiVcy = phi * Vcy = 1544.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2321.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5432.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2321.67 kN.
-. phiVsz = phi*Vsz = 2089.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2321.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5432.03 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2321.67 kN.
-. phiVsy = phi*Vsy = 2089.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 208.391 kN.
-. Vr = 3634.321 kN.
-. Ratio = Vu / Vr = 0.057 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 231.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 231.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117129,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2479.12       -53.77       -41.44         3.90         3.69
           ------------------------------------------------------------------------------
            DL+LL+Others     2479.12       -53.77       -41.44         3.90         3.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       41.44 kN-m.
           -. End Moments (My2) =       53.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -41.44 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -41.44 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.69 kN-m.
          -. End Moments (Mz2) =        3.90 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        3.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        3.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       408.009 kN-m.
          -. Mrz        =        35.938 kN-m.
          -. Mr         =       409.588 kN-m.
          -. Pu/Pr      =   0.102  --->  O.K !
          -. Muy/Mry    =   0.102  --->  O.K !
          -. Muz/Mrz    =   0.103  --->  O.K !
          -. Mu/Mr      =   0.103  --->  O.K !
          -. Ratio      =   0.103  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        872.32 kN.
          -. Vuz    =        175.03 kN.
          -. Muy    =        373.75 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.89

          -. Vuy    =         68.50 kN.
          -. Muz    =        145.20 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.09 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.89
```

( ). Compute shear strength of concrete.
-. Vuz = 175.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1756.88 kN.
-. phiVcz = phi * Vcz = 1581.19 kN.

-. Vuy = 68.50 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1756.88 kN.
-. phiVcy = phi * Vcy = 1581.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2334.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5391.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2334.36 kN.
-. phiVsz = phi*Vsz = 2100.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2334.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5391.61 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2334.36 kN.
-. phiVsy = phi*Vsy = 2100.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 187.959 kN.
-. Vr = 3682.117 kN.
-. Ratio = Vu / Vr = 0.051 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 208.84 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 208.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117130,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2495.78       -41.44       -30.32         3.69         3.25
           ------------------------------------------------------------------------------
            DL+LL+Others     2495.78       -41.44       -30.32         3.69         3.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       30.32 kN-m.
           -. End Moments (My2) =       41.44 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -30.32 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -30.32 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.25 kN-m.
          -. End Moments (Mz2) =        3.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        3.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        3.25 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       296.502 kN-m.
          -. Mrz        =        31.643 kN-m.
          -. Mr         =       298.185 kN-m.
          -. Pu/Pr      =   0.102  --->  O.K !
          -. Muy/Mry    =   0.102  --->  O.K !
          -. Muz/Mrz    =   0.103  --->  O.K !
          -. Mu/Mr      =   0.103  --->  O.K !
          -. Ratio      =   0.103  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        884.31 kN.
          -. Vuz    =        157.16 kN.
          -. Muy    =        286.25 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.97

          -. Vuy    =         61.37 kN.
          -. Muz    =        111.04 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.97 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.97
```

( ). Compute shear strength of concrete.
-. Vuz = 157.16 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1795.08 kN.
-. phiVcz = phi * Vcz = 1615.57 kN.

-. Vuy = 61.37 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1795.08 kN.
-. phiVcy = phi * Vcy = 1615.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2345.91 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5353.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2345.91 kN.
-. phiVsz = phi*Vsz = 2111.32 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2345.91 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5353.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2345.91 kN.
-. phiVsy = phi*Vsy = 2111.32 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 168.722 kN.
-. Vr = 3726.892 kN.
-. Ratio = Vu / Vr = 0.045 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 187.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 187.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-7.7725e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-7.7725e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-7.7725e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117131,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2512.43       -30.32       -20.31         3.25         2.58
           ------------------------------------------------------------------------------
            DL+LL+Others     2512.43       -30.32       -20.31         3.25         2.58
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       20.31 kN-m.
           -. End Moments (My2) =       30.32 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -20.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -20.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        2.58 kN-m.
          -. End Moments (Mz2) =        3.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        2.58 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        2.58 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       197.274 kN-m.
          -. Mrz        =        25.061 kN-m.
          -. Mr         =       198.860 kN-m.
          -. Pu/Pr      =   0.103  --->  O.K !
          -. Muy/Mry    =   0.103  --->  O.K !
          -. Muz/Mrz    =   0.103  --->  O.K !
          -. Mu/Mr      =   0.103  --->  O.K !
          -. Ratio      =   0.103  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        896.30 kN.
          -. Vuz    =        140.85 kN.
          -. Muy    =        207.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.05

          -. Vuy    =         54.90 kN.
          -. Muz    =         80.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.86 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.05
```

( ). Compute shear strength of concrete.
-. Vuz = 140.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1830.69 kN.
-. phiVcz = phi * Vcz = 1647.63 kN.

-. Vuy = 54.90 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1830.69 kN.
-. phiVcy = phi * Vcy = 1647.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2356.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5317.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2356.33 kN.
-. phiVsz = phi*Vsz = 2120.69 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2356.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5317.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2356.33 kN.
-. phiVsy = phi*Vsy = 2120.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 151.168 kN.
-. Vr = 3768.319 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 167.96 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 167.96 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117132,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2529.09       -20.31       -12.22         2.58         1.73
           ------------------------------------------------------------------------------
            DL+LL+Others     2529.09       -20.31       -12.22         2.58         1.73
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       12.22 kN-m.
           -. End Moments (My2) =       20.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -12.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -12.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.73 kN-m.
          -. End Moments (Mz2) =        2.58 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        1.73 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        1.73 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =       117.952 kN-m.
           -. Mrz        =        16.723 kN-m.
           -. Mr         =       119.132 kN-m.
           -. Pu/Pr      =   0.104  --->  O.K !
           -. Muy/Mry    =   0.104  --->  O.K !
           -. Muz/Mrz    =   0.103  --->  O.K !
           -. Mu/Mr      =   0.104  --->  O.K !
           -. Ratio      =   0.104  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =        908.29 kN.
           -. Vuz    =        112.72 kN.
           -. Muy    =        137.27 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  29.75 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   4.14

           -. Vuy    =         43.80 kN.
           -. Muz    =         53.10 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  29.75 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   4.14
```

( ). Compute shear strength of concrete.
-. Vuz = 112.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1868.62 kN.
-. phiVcz = phi * Vcz = 1681.76 kN.

-. Vuy = 43.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1868.62 kN.
-. phiVcy = phi * Vcy = 1681.76 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2367.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5279.86 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2367.05 kN.
-. phiVsz = phi*Vsz = 2130.34 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2367.05 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5279.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2367.05 kN.
-. phiVsy = phi*Vsy = 2130.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 120.930 kN.
-. Vr = 3812.107 kN.
-. Ratio = Vu / Vr = 0.032 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 134.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 134.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117133,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2545.75       -12.22        -6.59         1.73         0.95
           ------------------------------------------------------------------------------
            DL+LL+Others     2545.75       -12.22        -6.59         1.73         0.95
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        6.59 kN-m.
           -. End Moments (My2) =       12.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -6.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -6.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.95 kN-m.
          -. End Moments (Mz2) =        1.73 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.95 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =        63.205 kN-m.
           -. Mrz        =         9.099 kN-m.
           -. Mr         =        63.856 kN-m.
           -. Pu/Pr      =   0.104  --->  O.K !
           -. Muy/Mry    =   0.104  --->  O.K !
           -. Muz/Mrz    =   0.104  --->  O.K !
           -. Mu/Mr      =   0.104  --->  O.K !
           -. Ratio      =   0.104  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =        920.28 kN.
           -. Vuz    =         77.10 kN.
           -. Muy    =         80.92 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  29.65 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   4.22

           -. Vuy    =         29.86 kN.
           -. Muz    =         31.36 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  29.65 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   4.22
```

( ). Compute shear strength of concrete.
-. Vuz = 77.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1904.73 kN.
-. phiVcz = phi * Vcz = 1714.25 kN.

-. Vuy = 29.86 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1904.73 kN.
-. phiVcy = phi * Vcy = 1714.25 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2376.92 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5243.76 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2376.92 kN.
-. phiVsz = phi*Vsz = 2139.23 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2376.92 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5243.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2376.92 kN.
-. phiVsy = phi*Vsy = 2139.23 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 82.680 kN.
-. Vr = 3853.487 kN.
-. Ratio = Vu / Vr = 0.021 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 91.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 91.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117134,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2562.40        -6.59        -3.00         0.95         0.29
           ------------------------------------------------------------------------------
            DL+LL+Others     2562.40        -6.59        -3.00         0.95         0.29
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.00 kN-m.
           -. End Moments (My2) =        6.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.29 kN-m.
          -. End Moments (Mz2) =        0.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.29 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        28.533 kN-m.
          -. Mrz        =         2.721 kN-m.
          -. Mr         =        28.662 kN-m.
          -. Pu/Pr      =   0.105  --->  O.K !
          -. Muy/Mry    =   0.105  --->  O.K !
          -. Muz/Mrz    =   0.106  --->  O.K !
          -. Mu/Mr      =   0.106  --->  O.K !
          -. Ratio      =   0.106  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        944.26 kN.
          -. Vuz    =         48.03 kN.
          -. Muy    =         18.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.27

          -. Vuy    =         18.59 kN.
          -. Muz    =          9.67 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.27
```

( ). Compute shear strength of concrete.
-. Vuz = 48.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1929.59 kN.
-. phiVcz = phi * Vcz = 1736.63 kN.

-. Vuy = 18.59 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1929.59 kN.
-. phiVcy = phi * Vcy = 1736.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2383.55 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5218.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2383.55 kN.
-. phiVsz = phi*Vsz = 2145.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2383.55 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5218.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2383.55 kN.
-. phiVsy = phi*Vsy = 2145.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 51.500 kN.
-. Vr = 3881.826 kN.
-. Ratio = Vu / Vr = 0.013 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 57.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 57.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0013 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0013 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117135,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2579.06        -3.00        -0.99         0.29        -0.02
           ------------------------------------------------------------------------------
            DL+LL+Others     2579.06        -3.00        -0.99         0.29        -0.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.99 kN-m.
           -. End Moments (My2) =        3.00 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.02 kN-m.
          -. End Moments (Mz2) =        0.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         9.372 kN-m.
          -. Mrz        =         0.167 kN-m.
          -. Mr         =         9.373 kN-m.
          -. Pu/Pr      =   0.106  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        956.25 kN.
          -. Vuz    =         25.65 kN.
          -. Muy    =          5.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.54 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.31

          -. Vuy    =         10.81 kN.
          -. Muz    =          4.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.31
```

( ). Compute shear strength of concrete.
-. Vuz = 25.65 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1945.00 kN.
-. phiVcz = phi * Vcz = 1750.50 kN.

-. Vuy = 10.81 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1945.00 kN.
-. phiVcy = phi * Vcy = 1750.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2387.58 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5203.49 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2387.58 kN.
-. phiVsz = phi*Vsz = 2148.82 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2387.58 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5203.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2387.58 kN.
-. phiVsy = phi*Vsy = 2148.82 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 27.838 kN.
-. Vr = 3899.315 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 30.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 30.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117136,  LCB = 148-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2579.06        -0.99        -0.14        -0.02        -0.05
           ------------------------------------------------------------------------------
            DL+LL+Others     2579.06        -0.99        -0.14        -0.02        -0.05
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.14 kN-m.
           -. End Moments (My2) =        0.99 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.02 kN-m.
          -. End Moments (Mz2) =        0.05 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         9.372 kN-m.
          -. Mrz        =         0.167 kN-m.
          -. Mr         =         9.373 kN-m.
          -. Pu/Pr      =   0.106  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        968.24 kN.
          -. Vuz    =         10.02 kN.
          -. Muy    =          0.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.33

          -. Vuy    =          6.47 kN.
          -. Muz    =          1.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.33
```

( ). Compute shear strength of concrete.
-. Vuz = 10.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1954.74 kN.
-. phiVcz = phi * Vcz = 1759.27 kN.

-. Vuy = 6.47 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1954.74 kN.
-. phiVcy = phi * Vcy = 1759.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2390.10 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5193.74 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2390.10 kN.
-. phiVsz = phi*Vsz = 2151.09 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2390.10 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5193.74 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2390.10 kN.
-. phiVsy = phi*Vsy = 2151.09 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 11.931 kN.
-. Vr = 3910.357 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 13.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 13.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117137,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2612.37        -0.14         0.00        -0.05         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     2612.37        -0.14         0.00        -0.05         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.14 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.05 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.107  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        908.39 kN.
          -. Vuz    =          1.02 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.37

          -. Vuy    =          3.64 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.37
```

( ). Compute shear strength of concrete.
-. Vuz = 1.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1972.44 kN.
-. phiVcz = phi * Vcz = 1775.20 kN.

-. Vuy = 3.64 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1972.44 kN.
-. phiVcy = phi * Vcy = 1775.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2394.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5176.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2394.63 kN.
-. phiVsz = phi*Vsz = 2155.16 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2394.63 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5176.04 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2394.63 kN.
-. phiVsy = phi*Vsy = 2155.16 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 3.779 kN.
-. Vr = 3930.361 kN.
-. Ratio = Vu / Vr =9.615e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 4.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 4.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117202,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            664.81      3110.42      2394.13      1763.43      1613.18
           ------------------------------------------------------------------------------
            DL+LL+Others      664.81      3110.42      2394.13      1763.43      1613.18
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2394.13 kN-m.
           -. End Moments (My2) =     3110.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     3110.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     3110.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1613.18 kN-m.
          -. End Moments (Mz2) =     1763.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1763.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1763.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       948.483 kN.
          -. Mry        =      4396.297 kN-m.
          -. Mrz        =      2496.161 kN-m.
          -. Mr         =      5055.516 kN-m.
          -. Pu/Pr      =   0.701  --->  O.K !
          -. Muy/Mry    =   0.708  --->  O.K !
          -. Muz/Mrz    =   0.706  --->  O.K !
          -. Mu/Mr      =   0.708  --->  O.K !
          -. Ratio      =   0.708  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        664.81 kN.
          -. Vuz    =       1449.75 kN.
          -. Muy    =       3110.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  35.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.09

          -. Vuy    =        543.40 kN.
          -. Muz    =       1763.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.05 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.09
```

( ). Compute shear strength of concrete.
-. Vuz = 1449.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 944.46 kN.
-. phiVcz = phi * Vcz = 850.01 kN.

-. Vuy = 543.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 944.46 kN.
-. phiVcy = phi * Vcy = 850.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1928.57 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6204.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1928.57 kN.
-. phiVsz = phi*Vsz = 1735.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1928.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6204.03 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1928.57 kN.
-. phiVsy = phi*Vsy = 1735.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1548.241 kN.
-. Vr = 2585.724 kN.
-. Ratio = Vu / Vr = 0.599 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1720.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1720.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0130 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0130 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0130 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117203,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            676.77      2394.13      1733.85      1613.18      1468.49
           ------------------------------------------------------------------------------
            DL+LL+Others      676.77      2394.13      1733.85      1613.18      1468.49
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1733.85 kN-m.
           -. End Moments (My2) =     2394.13 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2394.13 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2394.13 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1468.49 kN-m.
          -. End Moments (Mz2) =     1613.18 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1613.18 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1613.18 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1182.918 kN.
          -. Mry        =      4202.763 kN-m.
          -. Mrz        =      2843.668 kN-m.
          -. Mr         =      5074.413 kN-m.
          -. Pu/Pr      =   0.572  --->  O.K !
          -. Muy/Mry    =   0.570  --->  O.K !
          -. Muz/Mrz    =   0.567  --->  O.K !
          -. Mu/Mr      =   0.572  --->  O.K !
          -. Ratio      =   0.572  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        676.77 kN.
          -. Vuz    =       1344.27 kN.
          -. Muy    =       2394.13 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.14 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28

          -. Vuy    =        505.87 kN.
          -. Muz    =       1613.18 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.28
```

( ). Compute shear strength of concrete.
-. Vuz = 1344.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1031.84 kN.
-. phiVcz = phi * Vcz = 928.65 kN.

-. Vuy = 505.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1031.84 kN.
-. phiVcy = phi * Vcy = 928.65 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1995.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6116.65 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1995.04 kN.
-. phiVsz = phi*Vsz = 1795.54 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1995.04 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6116.65 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1995.04 kN.
-. phiVsy = phi*Vsy = 1795.54 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1436.302 kN.
-. Vr = 2724.191 kN.
-. Ratio = Vu / Vr = 0.527 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1595.89 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1595.89 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0107 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0107 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0107 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117204,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            688.72      1733.85      1132.65      1468.49      1331.17
           ---------------------------------------------------------------------------
            DL+LL+Others      688.72      1733.85      1132.65      1468.49      1331.17
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1132.65 kN-m.
           -. End Moments (My2) =     1733.85 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1733.85 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1733.85 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1331.17 kN-m.
          -. End Moments (Mz2) =     1468.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1468.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1468.49 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1557.526 kN.
          -. Mry        =      3902.182 kN-m.
          -. Mrz        =      3288.223 kN-m.
          -. Mr         =      5102.885 kN-m.
          -. Pu/Pr      =   0.442  --->  O.K !
          -. Muy/Mry    =   0.444  --->  O.K !
          -. Muz/Mrz    =   0.447  --->  O.K !
          -. Mu/Mr      =   0.447  --->  O.K !
          -. Ratio      =   0.447  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        688.72 kN.
          -. Vuz    =       1234.96 kN.
          -. Muy    =       1733.85 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.49

          -. Vuy    =        466.99 kN.
          -. Muz    =       1468.49 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.32 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.49
```

( ). Compute shear strength of concrete.
-. Vuz = 1234.96 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1126.67 kN.
-. phiVcz = phi * Vcz = 1014.01 kN.

-. Vuy = 466.99 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1126.67 kN.
-. phiVcy = phi * Vcy = 1014.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2058.27 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6021.81 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2058.27 kN.
-. phiVsz = phi*Vsz = 1852.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2058.27 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6021.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2058.27 kN.
-. phiVsy = phi*Vsy = 1852.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1320.306 kN.
-. Vr = 2866.452 kN.
-. Ratio = Vu / Vr = 0.461 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1467.01 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1467.01 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0087 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0087 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0087 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117205,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            689.50       689.36       495.57      1817.04      1798.32
           ---------------------------------------------------------------------------
            DL+LL+Others      689.50       689.36       495.57      1817.04      1798.32
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      495.57 kN-m.
           -. End Moments (My2) =      689.36 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      689.36 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      689.36 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1798.32 kN-m.
          -. End Moments (Mz2) =     1817.04 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1817.04 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1817.04 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1805.605 kN.
          -. Mry        =      1824.036 kN-m.
          -. Mrz        =      4782.717 kN-m.
          -. Mr         =      5118.739 kN-m.
          -. Pu/Pr      =   0.382  --->  O.K !
          -. Muy/Mry    =   0.378  --->  O.K !
          -. Muz/Mrz    =   0.380  --->  O.K !
          -. Mu/Mr      =   0.382  --->  O.K !
          -. Ratio      =   0.382  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        700.68 kN.
          -. Vuz    =       1122.90 kN.
          -. Muy    =       1132.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71

          -. Vuy    =        427.11 kN.
          -. Muz    =       1331.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 1122.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1225.35 kN.
-. phiVcz = phi * Vcz = 1102.82 kN.

-. Vuy = 427.11 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1225.35 kN.
-. phiVcy = phi * Vcy = 1102.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2116.00 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5923.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2116.00 kN.
-. phiVsz = phi*Vsz = 1904.40 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2116.00 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5923.14 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2116.00 kN.
-. phiVsy = phi*Vsy = 1904.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1201.387 kN.
-. Vr = 3007.213 kN.
-. Ratio = Vu / Vr = 0.400 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1334.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1334.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0068 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0068 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0068 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117206,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            701.48       495.57       385.70      1798.32      1765.13
           ------------------------------------------------------------------------------
            DL+LL+Others      701.48       495.57       385.70      1798.32      1765.13
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      385.70 kN-m.
           -. End Moments (My2) =      495.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      495.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      495.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1765.13 kN-m.
          -. End Moments (Mz2) =     1798.32 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1798.32 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1798.32 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1927.699 kN.
          -. Mry        =      1355.180 kN-m.
          -. Mrz        =      4943.827 kN-m.
          -. Mr         =      5126.201 kN-m.
          -. Pu/Pr      =   0.364  --->  O.K !
          -. Muy/Mry    =   0.366  --->  O.K !
          -. Muz/Mrz    =   0.364  --->  O.K !
          -. Mu/Mr      =   0.366  --->  O.K !
          -. Ratio      =   0.366  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        712.64 kN.
          -. Vuz    =       1009.27 kN.
          -. Muy    =        592.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.00 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.92

          -. Vuy    =        386.67 kN.
          -. Muz    =       1203.34 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 1009.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1319.24 kN.
-. phiVcz = phi * Vcz = 1187.32 kN.

-. Vuy = 386.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1319.24 kN.
-. phiVcy = phi * Vcy = 1187.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2164.61 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5829.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2164.61 kN.
-. phiVsz = phi*Vsz = 1948.15 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2164.61 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5829.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2164.61 kN.
-. phiVsy = phi*Vsy = 1948.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1080.809 kN.
-. Vr = 3135.468 kN.
-. Ratio = Vu / Vr = 0.345 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1200.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1200.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0053 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0053 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117207,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            713.45       385.70       495.53      1765.13      1720.53
           ------------------------------------------------------------------------------
            DL+LL+Others      713.45       385.70       495.53      1765.13      1720.53
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      385.70 kN-m.
           -. End Moments (My2) =      495.53 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      385.70 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      385.70 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1720.53 kN-m.
          -. End Moments (Mz2) =     1765.13 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1765.13 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1765.13 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2044.053 kN.
          -. Mry        =      1095.831 kN-m.
          -. Mrz        =      5016.732 kN-m.
          -. Mr         =      5135.021 kN-m.
          -. Pu/Pr      =   0.349  --->  O.K !
          -. Muy/Mry    =   0.352  --->  O.K !
          -. Muz/Mrz    =   0.352  --->  O.K !
          -. Mu/Mr      =   0.352  --->  O.K !
          -. Ratio      =   0.352  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        736.59 kN.
          -. Vuz    =        895.34 kN.
          -. Muy    =        641.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        346.24 kN.
          -. Muz    =        987.39 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.04
```

( ). Compute shear strength of concrete.
-. Vuz = 895.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1372.95 kN.
-. phiVcz = phi * Vcz = 1235.65 kN.

-. Vuy = 346.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1372.95 kN.
-. phiVcy = phi * Vcy = 1235.65 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2190.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5775.54 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2190.05 kN.
-. phiVsz = phi*Vsz = 1971.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2190.05 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5775.54 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2190.05 kN.
-. phiVsy = phi*Vsy = 1971.04 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 959.959 kN.
-. Vr = 3206.695 kN.
-. Ratio = Vu / Vr = 0.299 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1066.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1066.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117208,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            725.42       495.53       598.52      1720.53      1665.01
           ------------------------------------------------------------------------------
            DL+LL+Others      725.42       495.53       598.52      1720.53      1665.01
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      495.53 kN-m.
           -. End Moments (My2) =      598.52 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      495.53 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      495.53 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1665.01 kN-m.
          -. End Moments (Mz2) =     1720.53 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1720.53 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1720.53 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2097.201 kN.
          -. Mry        =      1417.686 kN-m.
          -. Mrz        =      4936.000 kN-m.
          -. Mr         =      5135.556 kN-m.
          -. Pu/Pr      =   0.346  --->  O.K !
          -. Muy/Mry    =   0.350  --->  O.K !
          -. Muz/Mrz    =   0.349  --->  O.K !
          -. Mu/Mr      =   0.350  --->  O.K !
          -. Ratio      =   0.350  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        748.55 kN.
          -. Vuz    =        782.39 kN.
          -. Muy    =        972.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =        306.44 kN.
          -. Muz    =        902.40 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01
```

( ). Compute shear strength of concrete.
-. Vuz = 782.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1361.95 kN.
-. phiVcz = phi * Vcz = 1225.75 kN.

-. Vuy = 306.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1361.95 kN.
-. phiVcy = phi * Vcy = 1225.75 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2184.97 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5786.54 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2184.97 kN.
-. phiVsz = phi*Vsz = 1966.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2184.97 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5786.54 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2184.97 kN.
-. phiVsy = phi*Vsy = 1966.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 840.265 kN.
-. Vr = 3192.220 kN.
-. Ratio = Vu / Vr = 0.263 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 933.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 933.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0047 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117209,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            737.40       598.52       688.16      1665.01      1599.27
           ---------------------------------------------------------------------------
            DL+LL+Others      737.40       598.52       688.16      1665.01      1599.27
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      598.52 kN-m.
           -. End Moments (My2) =      688.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      598.52 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      598.52 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1599.27 kN-m.
          -. End Moments (Mz2) =     1665.01 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1665.01 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1665.01 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2144.864 kN.
          -. Mry        =      1741.054 kN-m.
          -. Mrz        =      4834.272 kN-m.
          -. Mr         =      5138.234 kN-m.
          -. Pu/Pr      =   0.344  --->  O.K !
          -. Muy/Mry    =   0.344  --->  O.K !
          -. Muz/Mrz    =   0.344  --->  O.K !
          -. Mu/Mr      =   0.344  --->  O.K !
          -. Ratio      =   0.344  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        760.52 kN.
          -. Vuz    =        671.76 kN.
          -. Muy    =       1256.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98

          -. Vuy    =        268.83 kN.
          -. Muz    =        830.65 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.86 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.98
```

( ). Compute shear strength of concrete.
-. Vuz = 671.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1344.38 kN.
-. phiVcz = phi * Vcz = 1209.94 kN.

-. Vuy = 268.83 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1344.38 kN.
-. phiVcy = phi * Vcy = 1209.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2176.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5804.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2176.72 kN.
-. phiVsz = phi*Vsz = 1959.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2176.72 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5804.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2176.72 kN.
-. phiVsy = phi*Vsy = 1959.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 723.558 kN.
-. Vr = 3168.990 kN.
-. Ratio = Vu / Vr = 0.228 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 803.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 803.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117210,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            749.37       688.16       763.16      1599.27      1523.84
           ------------------------------------------------------------------------------
            DL+LL+Others      749.37       688.16       763.16      1599.27      1523.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      688.16 kN-m.
           -. End Moments (My2) =      763.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      688.16 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      688.16 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1523.84 kN-m.
          -. End Moments (Mz2) =     1599.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1599.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1599.27 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2235.964 kN.
          -. Mry        =      2029.706 kN-m.
          -. Mrz        =      4728.760 kN-m.
          -. Mr         =      5145.958 kN-m.
          -. Pu/Pr      =   0.335  --->  O.K !
          -. Muy/Mry    =   0.339  --->  O.K !
          -. Muz/Mrz    =   0.338  --->  O.K !
          -. Mu/Mr      =   0.339  --->  O.K !
          -. Ratio      =   0.339  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        772.48 kN.
          -. Vuz    =        564.83 kN.
          -. Muy    =       1493.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.96 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.94

          -. Vuy    =        245.11 kN.
          -. Muz    =        768.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.94
```

( ). Compute shear strength of concrete.
-. Vuz = 564.83 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1326.91 kN.
-. phiVcz = phi * Vcz = 1194.22 kN.

-. Vuy = 245.11 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1326.91 kN.
-. phiVcy = phi * Vcy = 1194.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2168.34 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5821.58 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2168.34 kN.
-. phiVsz = phi*Vsz = 1951.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2168.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5821.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2168.34 kN.
-. phiVsy = phi*Vsy = 1951.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 615.721 kN.
-. Vr = 3145.728 kN.
-. Ratio = Vu / Vr = 0.196 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 684.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 684.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0053 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0053 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117211,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            784.44      1493.17      1687.30       768.52       712.16
           ---------------------------------------------------------------------------
            DL+LL+Others      784.44      1493.17      1687.30       768.52       712.16
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1493.17 kN-m.
           -. End Moments (My2) =     1687.30 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1687.30 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1687.30 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      712.16 kN-m.
          -. End Moments (Mz2) =      768.52 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      712.16 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      712.16 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

( ). Check tensile reinforcement.
-. Rho = 0.0321
-. Rho > Rho_max ---> Not Acceptable !!!

( ). Check moment capacity.
-. Pr_max = 24404.708 kN.
-. Pr = 2183.164 kN.
-. Mry = 4738.234 kN-m.
-. Mrz = 2002.965 kN-m.
-. Mr = 5144.194 kN-m.
-. Pu/Pr = 0.359 ---> O.K !
-. Muy/Mry = 0.356 ---> O.K !
-. Muz/Mrz = 0.356 ---> O.K !
-. Mu/Mr = 0.359 ---> O.K !
-. Ratio = 0.359 ---> O.K !

[[[*]]] ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.

( ). Compute shear parameter. (LCB = 151, POS = J)
-. phi = 0.90
-. Av = 0.0006 m^2.
-. Pu = 784.44 kN.
-. Vuz = 462.98 kN.
-. Muy = 1687.30 kN-m.
-. bvz = 1.20 m.
-. dvz = MAX[dvz_calc, 0.9*dz, 0.72*Hc] = 0.86 m.
-. thetaz = 32.04 Deg. [Clause 5.8.3.4.2]
-. betaz = 2.91

-. Vuy = 229.18 kN.
-. Muz = 712.16 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 32.04 Deg. [Clause 5.8.3.4.2]
-. betay = 2.91

( ). Compute shear strength of concrete.
-. Vuz = 462.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1312.58 kN.
-. phiVcz = phi * Vcz = 1181.32 kN.

-. Vuy = 229.18 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1312.58 kN.
-. phiVcy = phi * Vcy = 1181.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2161.34 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5835.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2161.34 kN.
-. phiVsz = phi*Vsz = 1945.21 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2161.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5835.91 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2161.34 kN.
-. phiVsy = phi*Vsy = 1945.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 516.595 kN.
-. Vr = 3126.523 kN.
-. Ratio = Vu / Vr = 0.165 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 573.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 573.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0055 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0055 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0055 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117212,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1701.86     -1697.88     -1876.16      -672.08      -702.59
           ---------------------------------------------------------------------------
            DL+LL+Others     1701.86     -1697.88     -1876.16      -672.08      -702.59
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1697.88 kN-m.
           -. End Moments (My2) =     1876.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1876.16 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1876.16 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      672.08 kN-m.
          -. End Moments (Mz2) =      702.59 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -702.59 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -702.59 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4472.647 kN.
          -. Mry        =      4894.666 kN-m.
          -. Mrz        =      1840.473 kN-m.
          -. Mr         =      5229.254 kN-m.
          -. Pu/Pr      =   0.381  --->  O.K !
          -. Muy/Mry    =   0.383  --->  O.K !
          -. Muz/Mrz    =   0.382  --->  O.K !
          -. Mu/Mr      =   0.383  --->  O.K !
          -. Ratio      =   0.383  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        796.41 kN.
          -. Vuz    =        367.57 kN.
          -. Muy    =       1846.11 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        213.68 kN.
          -. Muz    =        664.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 367.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1301.39 kN.
-. phiVcz = phi * Vcz = 1171.25 kN.

-. Vuy = 213.68 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1301.39 kN.
-. phiVcy = phi * Vcy = 1171.25 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2155.79 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5847.09 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2155.79 kN.
-. phiVsz = phi*Vsz = 1940.21 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2155.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5847.09 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2155.79 kN.
-. phiVsy = phi*Vsy = 1940.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 425.163 kN.
-. Vr = 3111.465 kN.
-. Ratio = Vu / Vr = 0.137 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 472.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 472.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0057 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0057 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0057 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117213,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1718.54     -1876.16     -2010.87      -702.59      -735.42
           ------------------------------------------------------------------------------
            DL+LL+Others     1718.54     -1876.16     -2010.87      -702.59      -735.42
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1876.16 kN-m.
           -. End Moments (My2) =     2010.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -2010.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -2010.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      702.59 kN-m.
          -. End Moments (Mz2) =      735.42 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -735.42 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -735.42 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4234.341 kN.
          -. Mry        =      4911.079 kN-m.
          -. Mrz        =      1797.141 kN-m.
          -. Mr         =      5229.571 kN-m.
          -. Pu/Pr      =   0.406  --->  O.K !
          -. Muy/Mry    =   0.409  --->  O.K !
          -. Muz/Mrz    =   0.409  --->  O.K !
          -. Mu/Mr      =   0.409  --->  O.K !
          -. Ratio      =   0.409  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        808.37 kN.
          -. Vuz    =        279.86 kN.
          -. Muy    =       1963.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.87

          -. Vuy    =        198.44 kN.
          -. Muz    =        629.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 279.86 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1294.77 kN.
-. phiVcz = phi * Vcz = 1165.29 kN.

-. Vuy = 198.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1294.77 kN.
-. phiVcy = phi * Vcy = 1165.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2152.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5853.72 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2152.47 kN.
-. phiVsz = phi*Vsz = 1937.23 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2152.47 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5853.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2152.47 kN.
-. phiVsy = phi*Vsy = 1937.23 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 343.074 kN.
-. Vr = 3102.520 kN.
-. Ratio = Vu / Vr = 0.111 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 381.19 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 381.19 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0058 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0058 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0058 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117214,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1735.23     -2010.87     -2087.61      -735.42      -758.81
           ------------------------------------------------------------------------------
            DL+LL+Others     1735.23     -2010.87     -2087.61      -735.42      -758.81
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2010.87 kN-m.
           -. End Moments (My2) =     2087.61 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -2087.61 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -2087.61 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      735.42 kN-m.
          -. End Moments (Mz2) =      758.81 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -758.81 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -758.81 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4101.227 kN.
          -. Mry        =      4911.060 kN-m.
          -. Mrz        =      1787.466 kN-m.
          -. Mr         =      5226.237 kN-m.
          -. Pu/Pr      =   0.423  --->  O.K !
          -. Muy/Mry    =   0.425  --->  O.K !
          -. Muz/Mrz    =   0.425  --->  O.K !
          -. Mu/Mr      =   0.425  --->  O.K !
          -. Ratio      =   0.425  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        797.28 kN.
          -. Vuz    =         96.85 kN.
          -. Muy    =        917.04 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.13

          -. Vuy    =        237.43 kN.
          -. Muz    =       1269.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.13
```

( ). Compute shear strength of concrete.
-. Vuz = 96.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1416.08 kN.
-. phiVcz = phi * Vcz = 1274.47 kN.

-. Vuy = 237.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1416.08 kN.
-. phiVcy = phi * Vcy = 1274.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2209.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5732.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2209.36 kN.
-. phiVsz = phi*Vsz = 1988.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2209.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5732.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2209.36 kN.
-. phiVsy = phi*Vsy = 1988.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 256.423 kN.
-. Vr = 3262.901 kN.
-. Ratio = Vu / Vr = 0.079 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 284.91 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 284.91 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117215,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1751.91     -2087.61     -2098.08      -758.81      -760.62
           ------------------------------------------------------------------------------
            DL+LL+Others     1751.91     -2087.61     -2098.08      -758.81      -760.62
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2087.61 kN-m.
           -. End Moments (My2) =     2098.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -2098.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -2098.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      758.81 kN-m.
          -. End Moments (Mz2) =      760.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -760.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -760.62 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4101.097 kN.
          -. Mry        =      4912.537 kN-m.
          -. Mrz        =      1783.400 kN-m.
          -. Mr         =      5226.235 kN-m.
          -. Pu/Pr      =   0.427  --->  O.K !
          -. Muy/Mry    =   0.427  --->  O.K !
          -. Muz/Mrz    =   0.427  --->  O.K !
          -. Mu/Mr      =   0.427  --->  O.K !
          -. Ratio      =   0.427  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        809.26 kN.
          -. Vuz    =         53.97 kN.
          -. Muy    =        932.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.41 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.17

          -. Vuy    =        243.13 kN.
          -. Muz    =       1182.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.41 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.17
```

( ). Compute shear strength of concrete.
-. Vuz = 53.97 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1430.42 kN.
-. phiVcz = phi * Vcz = 1287.37 kN.

-. Vuy = 243.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1430.42 kN.
-. phiVcy = phi * Vcy = 1287.37 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2215.58 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5718.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2215.58 kN.
-. phiVsz = phi*Vsz = 1994.02 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2215.58 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5718.07 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2215.58 kN.
-. phiVsy = phi*Vsy = 1994.02 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 249.052 kN.
-. Vr = 3281.394 kN.
-. Ratio = Vu / Vr = 0.076 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 276.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 276.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117216,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1751.93     -2098.08     -2052.28      -760.62      -743.46
           ------------------------------------------------------------------------------
            DL+LL+Others     1751.93     -2098.08     -2052.28      -760.62      -743.46
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2052.28 kN-m.
           -. End Moments (My2) =     2098.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -2098.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -2098.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      743.46 kN-m.
          -. End Moments (Mz2) =      760.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -760.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -760.62 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4101.097 kN.
          -. Mry        =      4912.537 kN-m.
          -. Mrz        =      1783.400 kN-m.
          -. Mr         =      5226.235 kN-m.
          -. Pu/Pr      =   0.427  --->  O.K !
          -. Muy/Mry    =   0.427  --->  O.K !
          -. Muz/Mrz    =   0.427  --->  O.K !
          -. Mu/Mr      =   0.427  --->  O.K !
          -. Ratio      =   0.427  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        821.24 kN.
          -. Vuz    =         77.71 kN.
          -. Muy    =        922.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.20

          -. Vuy    =        244.18 kN.
          -. Muz    =       1082.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.32 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.20
```

( ). Compute shear strength of concrete.
-. Vuz = 77.71 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1447.52 kN.
-. phiVcz = phi * Vcz = 1302.77 kN.

-. Vuy = 244.18 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1447.52 kN.
-. phiVcy = phi * Vcy = 1302.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2222.86 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5700.97 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2222.86 kN.
-. phiVsz = phi*Vsz = 2000.58 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2222.86 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5700.97 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2222.86 kN.
-. phiVsy = phi*Vsy = 2000.58 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 256.248 kN.
-. Vr = 3303.344 kN.
-. Ratio = Vu / Vr = 0.078 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 284.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 284.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117217,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                           -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1768.61     -2052.28     -1960.74      -743.46      -710.52
           ---------------------------------------------------------------------------
            DL+LL+Others     1768.61     -2052.28     -1960.74      -743.46      -710.52
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1960.74 kN-m.
           -. End Moments (My2) =     2052.28 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -2052.28 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -2052.28 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      710.52 kN-m.
          -. End Moments (Mz2) =      743.46 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -743.46 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -743.46 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4235.575 kN.
          -. Mry        =      4916.292 kN-m.
          -. Mrz        =      1781.699 kN-m.
          -. Mr         =      5229.185 kN-m.
          -. Pu/Pr      =   0.418  --->  O.K !
          -. Muy/Mry    =   0.417  --->  O.K !
          -. Muz/Mrz    =   0.417  --->  O.K !
          -. Mu/Mr      =   0.418  --->  O.K !
          -. Ratio      =   0.418  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        833.22 kN.
          -. Vuz    =        105.04 kN.
          -. Muy    =        891.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.22 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.25

          -. Vuy    =        240.80 kN.
          -. Muz    =        974.79 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.22 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 105.04 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1469.70 kN.
-. phiVcz = phi * Vcz = 1322.73 kN.

-. Vuy = 240.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1469.70 kN.
-. phiVcy = phi * Vcy = 1322.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2232.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5678.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2232.11 kN.
-. phiVsz = phi*Vsz = 2008.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2232.11 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5678.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2232.11 kN.
-. phiVsy = phi*Vsy = 2008.90 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 262.714 kN.
-. Vr = 3331.624 kN.
-. Ratio = Vu / Vr = 0.079 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 291.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 291.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117218,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1785.28     -1960.74     -1833.94      -710.52      -665.22
           ---------------------------------------------------------------------------
            DL+LL+Others     1785.28     -1960.74     -1833.94      -710.52      -665.22
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1833.94 kN-m.
           -. End Moments (My2) =     1960.74 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1960.74 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1960.74 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      665.22 kN-m.
          -. End Moments (Mz2) =      710.52 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -710.52 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -710.52 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4477.052 kN.
          -. Mry        =      4912.895 kN-m.
          -. Mrz        =      1787.177 kN-m.
          -. Mr         =      5227.862 kN-m.
          -. Pu/Pr      =   0.399  --->  O.K !
          -. Muy/Mry    =   0.399  --->  O.K !
          -. Muz/Mrz    =   0.398  --->  O.K !
          -. Mu/Mr      =   0.399  --->  O.K !
          -. Ratio      =   0.399  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1785.28 kN.
          -. Vuz    =        255.08 kN.
          -. Muy    =      -1960.74 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =        104.43 kN.
          -. Muz    =       -710.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.60 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 255.08 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1266.68 kN.
-. phiVcz = phi * Vcz = 1140.01 kN.

-. Vuy = 104.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1224.25 kN.
-. phiVcy = phi * Vcy = 1101.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2138.09 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5881.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2138.09 kN.
-. phiVsz = phi*Vsz = 1924.28 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2115.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5924.23 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2115.39 kN.
-. phiVsy = phi*Vsy = 1903.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 275.630 kN.
-. Vr = 3005.682 kN.
-. Ratio = Vu / Vr = 0.092 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 306.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 306.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117219,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1801.96     -1833.94     -1682.03      -665.22      -611.02
           ------------------------------------------------------------------------------
            DL+LL+Others     1801.96     -1833.94     -1682.03      -665.22      -611.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1682.03 kN-m.
           -. End Moments (My2) =     1833.94 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1833.94 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1833.94 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      611.02 kN-m.
          -. End Moments (Mz2) =      665.22 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -665.22 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -665.22 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4862.935 kN.
          -. Mry        =      4912.331 kN-m.
          -. Mrz        =      1788.247 kN-m.
          -. Mr         =      5227.698 kN-m.
          -. Pu/Pr      =   0.371  --->  O.K !
          -. Muy/Mry    =   0.373  --->  O.K !
          -. Muz/Mrz    =   0.372  --->  O.K !
          -. Mu/Mr      =   0.373  --->  O.K !
          -. Ratio      =   0.373  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1801.96 kN.
          -. Vuz    =        304.49 kN.
          -. Muy    =      -1833.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        114.35 kN.
          -. Muz    =       -665.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 304.49 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1281.24 kN.
-. phiVcz = phi * Vcz = 1153.12 kN.

-. Vuy = 114.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1239.00 kN.
-. phiVcy = phi * Vcy = 1115.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2145.61 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5867.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2145.61 kN.
-. phiVsz = phi*Vsz = 1931.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.42 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5909.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.42 kN.
-. phiVsy = phi*Vsy = 1911.08 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 325.250 kN.
-. Vr = 3026.172 kN.
-. Ratio = Vu / Vr = 0.107 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 361.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 361.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117220,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1818.63     -1682.03     -1514.65      -611.02      -551.24
           ------------------------------------------------------------------------------
            DL+LL+Others     1818.63     -1682.03     -1514.65      -611.02      -551.24
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1514.65 kN-m.
           -. End Moments (My2) =     1682.03 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1682.03 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1682.03 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      551.24 kN-m.
          -. End Moments (Mz2) =      611.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -611.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -611.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      5317.522 kN.
          -. Mry        =      4903.759 kN-m.
          -. Mrz        =      1778.629 kN-m.
          -. Mr         =      5216.356 kN-m.
          -. Pu/Pr      =   0.342  --->  O.K !
          -. Muy/Mry    =   0.343  --->  O.K !
          -. Muz/Mrz    =   0.344  --->  O.K !
          -. Mu/Mr      =   0.344  --->  O.K !
          -. Ratio      =   0.344  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1818.63 kN.
          -. Vuz    =        335.28 kN.
          -. Muy    =      -1682.03 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89

          -. Vuy    =        122.58 kN.
          -. Muz    =       -611.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.79
```

( ). Compute shear strength of concrete.
-. Vuz = 335.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1303.69 kN.
-. phiVcz = phi * Vcz = 1173.32 kN.

-. Vuy = 122.58 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1261.75 kN.
-. phiVcy = phi * Vcy = 1135.58 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2156.94 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5844.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2156.94 kN.
-. phiVsz = phi*Vsz = 1941.24 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2135.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5886.73 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2135.51 kN.
-. phiVsy = phi*Vsy = 1921.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 356.989 kN.
-. Vr = 3057.540 kN.
-. Ratio = Vu / Vr = 0.117 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 396.65 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 396.65 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117221,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1835.31     -1514.65     -1340.57      -551.24      -488.95
           ------------------------------------------------------------------------------
            DL+LL+Others     1835.31     -1514.65     -1340.57      -551.24      -488.95
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1340.57 kN-m.
           -. End Moments (My2) =     1514.65 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1514.65 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1514.65 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      488.95 kN-m.
          -. End Moments (Mz2) =      551.24 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -551.24 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -551.24 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      5981.673 kN.
          -. Mry        =      4888.614 kN-m.
          -. Mrz        =      1778.450 kN-m.
          -. Mr         =      5202.060 kN-m.
          -. Pu/Pr      =   0.307  --->  O.K !
          -. Muy/Mry    =   0.310  --->  O.K !
          -. Muz/Mrz    =   0.310  --->  O.K !
          -. Mu/Mr      =   0.310  --->  O.K !
          -. Ratio      =   0.310  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1835.31 kN.
          -. Vuz    =        348.57 kN.
          -. Muy    =      -1514.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        126.65 kN.
          -. Muz    =       -551.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86
```

( ). Compute shear strength of concrete.
-. Vuz = 348.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1332.91 kN.
-. phiVcz = phi * Vcz = 1199.62 kN.

-. Vuy = 126.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1291.44 kN.
-. phiVcy = phi * Vcy = 1162.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2171.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5815.57 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2171.24 kN.
-. phiVsz = phi*Vsz = 1954.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2150.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5857.04 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2150.79 kN.
-. phiVsy = phi*Vsy = 1935.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 370.863 kN.
-. Vr = 3098.013 kN.
-. Ratio = Vu / Vr = 0.120 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 412.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 412.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117222,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1851.98     -1340.57     -1167.59      -488.95      -426.90
           ------------------------------------------------------------------------------
            DL+LL+Others     1851.98     -1340.57     -1167.59      -488.95      -426.90
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1167.59 kN-m.
           -. End Moments (My2) =     1340.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1340.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1340.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      426.90 kN-m.
          -. End Moments (Mz2) =      488.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -488.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -488.95 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      6655.684 kN.
          -. Mry        =      4855.091 kN-m.
          -. Mrz        =      1767.155 kN-m.
          -. Mr         =      5166.696 kN-m.
          -. Pu/Pr      =   0.278  --->  O.K !
          -. Muy/Mry    =   0.276  --->  O.K !
          -. Muz/Mrz    =   0.277  --->  O.K !
          -. Mu/Mr      =   0.278  --->  O.K !
          -. Ratio      =   0.278  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1851.98 kN.
          -. Vuz    =        346.28 kN.
          -. Muy    =      -1340.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.73 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.03

          -. Vuy    =        125.54 kN.
          -. Muz    =       -488.95 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.94
```

( ). Compute shear strength of concrete.
-. Vuz = 346.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1367.70 kN.
-. phiVcz = phi * Vcz = 1230.93 kN.

-. Vuy = 125.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1326.87 kN.
-. phiVcy = phi * Vcy = 1194.18 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2187.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5780.78 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2187.63 kN.
-. phiVsz = phi*Vsz = 1968.87 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2168.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5821.62 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2168.32 kN.
-. phiVsy = phi*Vsy = 1951.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 368.331 kN.
-. Vr = 3145.669 kN.
-. Ratio = Vu / Vr = 0.117 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 409.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 409.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117223,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1868.65     -1167.59     -1002.42      -426.90      -367.47
           ------------------------------------------------------------------------------
            DL+LL+Others     1868.65     -1167.59     -1002.42      -426.90      -367.47
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1002.42 kN-m.
           -. End Moments (My2) =     1167.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1167.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1167.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      367.47 kN-m.
          -. End Moments (Mz2) =      426.90 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -426.90 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -426.90 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7656.048 kN.
          -. Mry        =      4783.745 kN-m.
          -. Mrz        =      1745.791 kN-m.
          -. Mr         =      5092.348 kN-m.
          -. Pu/Pr      =   0.244  --->  O.K !
          -. Muy/Mry    =   0.244  --->  O.K !
          -. Muz/Mrz    =   0.245  --->  O.K !
          -. Mu/Mr      =   0.245  --->  O.K !
          -. Ratio      =   0.245  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1868.65 kN.
          -. Vuz    =        330.56 kN.
          -. Muy    =      -1167.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.11

          -. Vuy    =        119.84 kN.
          -. Muz    =       -426.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.74 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.03
```

( ). Compute shear strength of concrete.
-. Vuz = 330.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1406.69 kN.
-. phiVcz = phi * Vcz = 1266.02 kN.

-. Vuy = 119.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1366.68 kN.
-. phiVcy = phi * Vcy = 1230.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2205.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5741.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2205.24 kN.
-. phiVsz = phi*Vsz = 1984.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2187.16 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5781.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2187.16 kN.
-. phiVsy = phi*Vsy = 1968.44 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 351.615 kN.
-. Vr = 3198.451 kN.
-. Ratio = Vu / Vr = 0.110 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 390.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 390.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117224,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1885.32     -1002.42      -849.98      -367.47      -312.42
           ------------------------------------------------------------------------------
            DL+LL+Others     1885.32     -1002.42      -849.98      -367.47      -312.42
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      849.98 kN-m.
           -. End Moments (My2) =     1002.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1002.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1002.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      312.42 kN-m.
          -. End Moments (Mz2) =      367.47 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -367.47 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -367.47 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8732.853 kN.
          -. Mry        =      4633.650 kN-m.
          -. Mrz        =      1708.713 kN-m.
          -. Mr         =      4938.665 kN-m.
          -. Pu/Pr      =   0.216  --->  O.K !
          -. Muy/Mry    =   0.216  --->  O.K !
          -. Muz/Mrz    =   0.215  --->  O.K !
          -. Mu/Mr      =   0.216  --->  O.K !
          -. Ratio      =   0.216  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1885.32 kN.
          -. Vuz    =        305.02 kN.
          -. Muy    =      -1002.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.21

          -. Vuy    =        110.74 kN.
          -. Muz    =       -367.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.52 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.12
```

( ). Compute shear strength of concrete.
-. Vuz = 305.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1448.13 kN.
-. phiVcz = phi * Vcz = 1303.32 kN.

-. Vuy = 110.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1409.12 kN.
-. phiVcy = phi * Vcy = 1268.21 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2223.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5700.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2223.12 kN.
-. phiVsz = phi*Vsz = 2000.81 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2206.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5739.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2206.31 kN.
-. phiVsy = phi*Vsy = 1985.68 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 324.503 kN.
-. Vr = 3253.884 kN.
-. Ratio = Vu / Vr = 0.100 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 360.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 360.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117225,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1901.99      -849.98      -709.54      -312.42      -261.58
           ------------------------------------------------------------------------------
            DL+LL+Others     1901.99      -849.98      -709.54      -312.42      -261.58
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      709.54 kN-m.
           -. End Moments (My2) =      849.98 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -849.98 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -849.98 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      261.58 kN-m.
          -. End Moments (Mz2) =      312.42 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -312.42 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -312.42 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10126.209 kN.
          -. Mry        =      4522.081 kN-m.
          -. Mrz        =      1659.858 kN-m.
          -. Mr         =      4817.089 kN-m.
          -. Pu/Pr      =   0.188  --->  O.K !
          -. Muy/Mry    =   0.188  --->  O.K !
          -. Muz/Mrz    =   0.188  --->  O.K !
          -. Mu/Mr      =   0.188  --->  O.K !
          -. Ratio      =   0.188  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1901.99 kN.
          -. Vuz    =        281.00 kN.
          -. Muy    =       -849.98 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.29

          -. Vuy    =        102.19 kN.
          -. Muz    =       -312.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.21
```

( ). Compute shear strength of concrete.
-. Vuz = 281.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1488.58 kN.
-. phiVcz = phi * Vcz = 1339.72 kN.

-. Vuy = 102.19 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1450.67 kN.
-. phiVcy = phi * Vcy = 1305.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2239.81 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5659.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2239.81 kN.
-. phiVsz = phi*Vsz = 2015.82 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2224.19 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5697.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2224.19 kN.
-. phiVsy = phi*Vsy = 2001.77 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 299.009 kN.
-. Vr = 3307.381 kN.
-. Ratio = Vu / Vr = 0.090 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 332.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 332.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117226,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1918.66      -709.54      -582.91      -261.58      -215.60
           ------------------------------------------------------------------------------
            DL+LL+Others     1918.66      -709.54      -582.91      -261.58      -215.60
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      582.91 kN-m.
           -. End Moments (My2) =      709.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -709.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -709.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      215.60 kN-m.
          -. End Moments (Mz2) =      261.58 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -261.58 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -261.58 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11832.266 kN.
          -. Mry        =      4372.160 kN-m.
          -. Mrz        =      1609.086 kN-m.
          -. Mr         =      4658.856 kN-m.
          -. Pu/Pr      =   0.162  --->  O.K !
          -. Muy/Mry    =   0.162  --->  O.K !
          -. Muz/Mrz    =   0.163  --->  O.K !
          -. Mu/Mr      =   0.163  --->  O.K !
          -. Ratio      =   0.163  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1918.66 kN.
          -. Vuz    =        253.35 kN.
          -. Muy    =       -709.54 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.95 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.38

          -. Vuy    =         92.33 kN.
          -. Muz    =       -261.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.30
```

( ). Compute shear strength of concrete.
-. Vuz = 253.35 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1529.03 kN.
-. phiVcz = phi * Vcz = 1376.13 kN.

-. Vuy = 92.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1492.36 kN.
-. phiVcy = phi * Vcy = 1343.12 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2255.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5619.45 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2255.78 kN.
-. phiVsz = phi*Vsz = 2030.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2241.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5656.13 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2241.33 kN.
-. phiVsy = phi*Vsy = 2017.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 269.648 kN.
-. Vr = 3360.316 kN.
-. Ratio = Vu / Vr = 0.080 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 299.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 299.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0001 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117227,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1935.32      -582.91      -471.15      -215.60      -174.91
           ------------------------------------------------------------------------------
            DL+LL+Others     1935.32      -582.91      -471.15      -215.60      -174.91
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      471.15 kN-m.
           -. End Moments (My2) =      582.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -582.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -582.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      174.91 kN-m.
          -. End Moments (Mz2) =      215.60 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -215.60 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -215.60 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     13930.826 kN.
          -. Mry        =      4151.508 kN-m.
          -. Mrz        =      1545.090 kN-m.
          -. Mr         =      4429.709 kN-m.
          -. Pu/Pr      =   0.139  --->  O.K !
          -. Muy/Mry    =   0.140  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.140  --->  O.K !
          -. Ratio      =   0.140  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1935.32 kN.
          -. Vuz    =        223.57 kN.
          -. Muy    =       -582.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.47

          -. Vuy    =         81.71 kN.
          -. Muz    =       -215.60 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.39
```

( ). Compute shear strength of concrete.
-. Vuz = 223.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1568.43 kN.
-. phiVcz = phi * Vcz = 1411.58 kN.

-. Vuy = 81.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1533.07 kN.
-. phiVcy = phi * Vcy = 1379.76 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2270.69 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5580.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2270.69 kN.
-. phiVsz = phi*Vsz = 2043.62 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2257.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5615.42 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2257.33 kN.
-. phiVsy = phi*Vsy = 2031.60 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 238.038 kN.
-. Vr = 3411.361 kN.
-. Ratio = Vu / Vr = 0.070 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 264.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 264.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117228,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1951.99      -471.15      -373.77      -174.91      -139.34
           ------------------------------------------------------------------------------
            DL+LL+Others     1951.99      -471.15      -373.77      -174.91      -139.34
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      373.77 kN-m.
           -. End Moments (My2) =      471.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -471.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -471.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      139.34 kN-m.
          -. End Moments (Mz2) =      174.91 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -174.91 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -174.91 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     16048.781 kN.
          -. Mry        =      3880.429 kN-m.
          -. Mrz        =      1439.245 kN-m.
          -. Mr         =      4138.739 kN-m.
          -. Pu/Pr      =   0.122  --->  O.K !
          -. Muy/Mry    =   0.121  --->  O.K !
          -. Muz/Mrz    =   0.122  --->  O.K !
          -. Mu/Mr      =   0.122  --->  O.K !
          -. Ratio      =   0.122  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1951.99 kN.
          -. Vuz    =        194.81 kN.
          -. Muy    =       -471.15 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.55

          -. Vuy    =         71.44 kN.
          -. Muz    =       -174.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.48
```

( ). Compute shear strength of concrete.
-. Vuz = 194.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1605.32 kN.
-. phiVcz = phi * Vcz = 1444.79 kN.

-. Vuy = 71.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1571.31 kN.
-. phiVcy = phi * Vcy = 1414.18 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2284.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5543.17 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2284.11 kN.
-. phiVsz = phi*Vsz = 2055.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2271.75 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5577.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2271.75 kN.
-. phiVsy = phi*Vsy = 2044.58 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 207.495 kN.
-. Vr = 3458.754 kN.
-. Ratio = Vu / Vr = 0.060 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 230.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 230.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117229,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1968.66      -373.77      -285.99      -139.34      -107.17
           ------------------------------------------------------------------------------
            DL+LL+Others     1968.66      -373.77      -285.99      -139.34      -107.17
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      285.99 kN-m.
           -. End Moments (My2) =      373.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -373.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -373.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      107.17 kN-m.
          -. End Moments (Mz2) =      139.34 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -139.34 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -139.34 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     18345.733 kN.
          -. Mry        =      3511.806 kN-m.
          -. Mrz        =      1307.001 kN-m.
          -. Mr         =      3747.137 kN-m.
          -. Pu/Pr      =   0.107  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1968.66 kN.
          -. Vuz    =        175.62 kN.
          -. Muy    =       -373.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.62

          -. Vuy    =         64.57 kN.
          -. Muz    =       -139.34 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.55
```

( ). Compute shear strength of concrete.
-. Vuz = 175.62 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1637.13 kN.
-. phiVcz = phi * Vcz = 1473.41 kN.

-. Vuy = 64.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1604.36 kN.
-. phiVcy = phi * Vcy = 1443.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2295.28 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5511.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2295.28 kN.
-. phiVsz = phi*Vsz = 2065.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2283.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5544.12 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2283.77 kN.
-. phiVsy = phi*Vsy = 2055.39 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 187.112 kN.
-. Vr = 3499.316 kN.
-. Ratio = Vu / Vr = 0.053 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 207.90 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 207.90 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117230,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2585.36       -55.13       -40.66       -63.63       -48.87
           ------------------------------------------------------------------------------
            DL+LL+Others     2585.36       -55.13       -40.66       -63.63       -48.87
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       40.66 kN-m.
           -. End Moments (My2) =       55.13 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -40.66 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -40.66 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       48.87 kN-m.
          -. End Moments (Mz2) =       63.63 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -48.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -48.87 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       383.894 kN-m.
          -. Mrz        =       461.240 kN-m.
          -. Mr         =       600.098 kN-m.
          -. Pu/Pr      =   0.106  --->  O.K !
          -. Muy/Mry    =   0.106  --->  O.K !
          -. Muz/Mrz    =   0.106  --->  O.K !
          -. Mu/Mr      =   0.106  --->  O.K !
          -. Ratio      =   0.106  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       1985.32 kN.
          -. Vuz    =        157.56 kN.
          -. Muy    =       -285.99 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.69

          -. Vuy    =         58.09 kN.
          -. Muz    =       -107.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.52 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.62
```

( ). Compute shear strength of concrete.
-. Vuz = 157.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1666.91 kN.
-. phiVcz = phi * Vcz = 1500.22 kN.

-. Vuy = 58.09 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1635.38 kN.
-. phiVcy = phi * Vcy = 1471.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2305.43 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5481.58 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2305.43 kN.
-. phiVsz = phi*Vsz = 2074.89 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2294.68 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5513.11 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2294.68 kN.
-. phiVsy = phi*Vsy = 2065.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 167.928 kN.
-. Vr = 3537.054 kN.
-. Ratio = Vu / Vr = 0.047 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 186.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 186.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117231,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2602.01       -40.66       -27.58       -48.87       -35.29
           ------------------------------------------------------------------------------
            DL+LL+Others     2602.01       -40.66       -27.58       -48.87       -35.29
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       27.58 kN-m.
           -. End Moments (My2) =       40.66 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -27.58 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -27.58 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       35.29 kN-m.
          -. End Moments (Mz2) =       48.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -35.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -35.29 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       258.432 kN-m.
          -. Mrz        =       331.146 kN-m.
          -. Mr         =       420.053 kN-m.
          -. Pu/Pr      =   0.107  --->  O.K !
          -. Muy/Mry    =   0.107  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2001.98 kN.
          -. Vuz    =        141.10 kN.
          -. Muy    =       -207.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.75

          -. Vuy    =         52.16 kN.
          -. Muz    =        -78.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.41 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.68
```

( ). Compute shear strength of concrete.
-. Vuz = 141.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1694.42 kN.
-. phiVcz = phi * Vcz = 1524.98 kN.

-. Vuy = 52.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1664.10 kN.
-. phiVcy = phi * Vcy = 1497.69 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2314.55 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5454.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2314.55 kN.
-. phiVsz = phi*Vsz = 2083.09 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2304.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5484.39 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2304.49 kN.
-. phiVsy = phi*Vsy = 2074.04 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 150.431 kN.
-. Vr = 3571.726 kN.
-. Ratio = Vu / Vr = 0.042 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 167.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 167.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117232,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2618.67       -27.58       -16.91       -35.29       -23.71
           ------------------------------------------------------------------------------
            DL+LL+Others     2618.67       -27.58       -16.91       -35.29       -23.71
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       16.91 kN-m.
           -. End Moments (My2) =       27.58 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -16.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -16.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       23.71 kN-m.
          -. End Moments (Mz2) =       35.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -23.71 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -23.71 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       157.686 kN-m.
          -. Mrz        =       220.856 kN-m.
          -. Mr         =       271.371 kN-m.
          -. Pu/Pr      =   0.107  --->  O.K !
          -. Muy/Mry    =   0.107  --->  O.K !
          -. Muz/Mrz    =   0.107  --->  O.K !
          -. Mu/Mr      =   0.107  --->  O.K !
          -. Ratio      =   0.107  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2018.65 kN.
          -. Vuz    =        112.75 kN.
          -. Muy    =       -136.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.81

          -. Vuy    =         41.96 kN.
          -. Muz    =        -52.33 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.75
```

( ). Compute shear strength of concrete.
-. Vuz = 112.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1723.52 kN.
-. phiVcz = phi * Vcz = 1551.17 kN.

-. Vuy = 41.96 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1694.54 kN.
-. phiVcy = phi * Vcy = 1525.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2323.93 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5424.96 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2323.93 kN.
-. phiVsz = phi*Vsz = 2091.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2314.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5453.94 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2314.59 kN.
-. phiVsy = phi*Vsy = 2083.13 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 120.309 kN.
-. Vr = 3608.217 kN.
-. Ratio = Vu / Vr = 0.033 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 133.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 133.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0025 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117233,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2635.33       -16.91        -9.36       -23.71       -14.79
           ------------------------------------------------------------------------------
            DL+LL+Others     2635.33       -16.91        -9.36       -23.71       -14.79
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        9.36 kN-m.
           -. End Moments (My2) =       16.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -9.36 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -9.36 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       14.79 kN-m.
          -. End Moments (Mz2) =       23.71 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -14.79 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -14.79 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        86.697 kN-m.
          -. Mrz        =       136.980 kN-m.
          -. Mr         =       162.111 kN-m.
          -. Pu/Pr      =   0.108  --->  O.K !
          -. Muy/Mry    =   0.108  --->  O.K !
          -. Muz/Mrz    =   0.108  --->  O.K !
          -. Mu/Mr      =   0.108  --->  O.K !
          -. Ratio      =   0.108  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2035.31 kN.
          -. Vuz    =         76.93 kN.
          -. Muy    =        -80.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.11 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.88

          -. Vuy    =         29.07 kN.
          -. Muz    =        -31.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.81
```

( ). Compute shear strength of concrete.
-. Vuz = 76.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1750.96 kN.
-. phiVcz = phi * Vcz = 1575.86 kN.

-. Vuy = 29.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1723.30 kN.
-. phiVcy = phi * Vcy = 1550.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2332.53 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5397.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2332.53 kN.
-. phiVsz = phi*Vsz = 2099.28 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2323.86 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5425.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2323.86 kN.
-. phiVsy = phi*Vsy = 2091.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 82.236 kN.
-. Vr = 3642.445 kN.
-. Ratio = Vu / Vr = 0.023 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 91.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 91.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117234,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2651.98        -9.36        -4.42       -14.79        -8.29
           ------------------------------------------------------------------------------
            DL+LL+Others     2651.98        -9.36        -4.42       -14.79        -8.29
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.42 kN-m.
           -. End Moments (My2) =        9.36 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.29 kN-m.
          -. End Moments (Mz2) =       14.79 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.29 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        40.623 kN-m.
          -. Mrz        =        76.343 kN-m.
          -. Mr         =        86.478 kN-m.
          -. Pu/Pr      =   0.109  --->  O.K !
          -. Muy/Mry    =   0.109  --->  O.K !
          -. Muz/Mrz    =   0.109  --->  O.K !
          -. Mu/Mr      =   0.109  --->  O.K !
          -. Ratio      =   0.109  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2068.62 kN.
          -. Vuz    =         47.76 kN.
          -. Muy    =        -18.15 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.92

          -. Vuy    =         18.57 kN.
          -. Muz    =        -10.85 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.86
```

( ). Compute shear strength of concrete.
-. Vuz = 47.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1768.87 kN.
-. phiVcz = phi * Vcz = 1591.98 kN.

-. Vuy = 18.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1742.11 kN.
-. phiVcy = phi * Vcy = 1567.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2338.03 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5379.62 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2338.03 kN.
-. phiVsz = phi*Vsz = 2104.23 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2329.78 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5406.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2329.78 kN.
-. phiVsy = phi*Vsy = 2096.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 51.242 kN.
-. Vr = 3664.704 kN.
-. Ratio = Vu / Vr = 0.014 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 56.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 56.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117235,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2668.64        -4.42        -1.56        -8.29        -3.70
           ------------------------------------------------------------------------------
            DL+LL+Others     2668.64        -4.42        -1.56        -8.29        -3.70
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.56 kN-m.
           -. End Moments (My2) =        4.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.56 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.56 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.70 kN-m.
          -. End Moments (Mz2) =        8.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.70 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.70 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        14.271 kN-m.
          -. Mrz        =        33.851 kN-m.
          -. Mr         =        36.736 kN-m.
          -. Pu/Pr      =   0.109  --->  O.K !
          -. Muy/Mry    =   0.110  --->  O.K !
          -. Muz/Mrz    =   0.109  --->  O.K !
          -. Mu/Mr      =   0.110  --->  O.K !
          -. Ratio      =   0.110  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2085.28 kN.
          -. Vuz    =         25.39 kN.
          -. Muy    =         -5.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.02 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.94

          -. Vuy    =         12.01 kN.
          -. Muz    =         -4.89 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.88
```

( ). Compute shear strength of concrete.
-. Vuz = 25.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1779.83 kN.
-. phiVcz = phi * Vcz = 1601.84 kN.

-. Vuy = 12.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1753.63 kN.
-. phiVcy = phi * Vcy = 1578.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2341.35 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5368.66 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2341.35 kN.
-. phiVsz = phi*Vsz = 2107.22 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2333.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5394.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2333.36 kN.
-. phiVsy = phi*Vsy = 2100.02 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 28.092 kN.
-. Vr = 3678.290 kN.
-. Ratio = Vu / Vr = 0.008 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 31.21 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 31.21 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117236,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2685.29        -1.56        -0.28        -3.70        -0.93
           ------------------------------------------------------------------------------
            DL+LL+Others     2685.29        -1.56        -0.28        -3.70        -0.93
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.28 kN-m.
           -. End Moments (My2) =        1.56 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.28 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.28 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.93 kN-m.
          -. End Moments (Mz2) =        3.70 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.93 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.93 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         2.525 kN-m.
          -. Mrz        =         8.455 kN-m.
          -. Mr         =         8.824 kN-m.
          -. Pu/Pr      =   0.110  --->  O.K !
          -. Muy/Mry    =   0.110  --->  O.K !
          -. Muz/Mrz    =   0.110  --->  O.K !
          -. Mu/Mr      =   0.110  --->  O.K !
          -. Ratio      =   0.110  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2101.94 kN.
          -. Vuz    =          9.89 kN.
          -. Muy    =         -0.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.00 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.95

          -. Vuy    =          7.28 kN.
          -. Muz    =         -1.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.90
```

( ). Compute shear strength of concrete.
-. Vuz = 9.89 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1786.62 kN.
-. phiVcz = phi * Vcz = 1607.96 kN.

-. Vuy = 7.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1760.77 kN.
-. phiVcy = phi * Vcy = 1584.70 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2343.39 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5361.87 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2343.39 kN.
-. phiVsz = phi*Vsz = 2109.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2335.56 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5387.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2335.56 kN.
-. phiVsy = phi*Vsy = 2102.00 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 12.278 kN.
-. Vr = 3686.698 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 13.64 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 13.64 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117237,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2701.95        -0.28         0.00        -0.93         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     2701.95        -0.28         0.00        -0.93         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.28 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.93 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.111  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.111  --->  O.K !
          -. Ratio      =   0.111  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2129.54 kN.
          -. Vuz    =          1.02 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.90

          -. Vuy    =          3.86 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.90
```

( ). Compute shear strength of concrete.
-. Vuz = 1.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1761.62 kN.
-. phiVcz = phi * Vcz = 1585.46 kN.

-. Vuy = 3.86 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1761.62 kN.
-. phiVcy = phi * Vcy = 1585.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2335.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5386.86 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2335.82 kN.
-. phiVsz = phi*Vsz = 2102.24 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2335.82 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5386.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2335.82 kN.
-. phiVsy = phi*Vsy = 2102.24 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 3.998 kN.
-. Vr = 3687.698 kN.
-. Ratio = Vu / Vr = 0.001 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 4.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 4.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118102,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2013.70     -3018.31     -2270.37      -666.62      -564.05
           ---------------------------------------------------------------------------
            DL+LL+Others     2013.70     -3018.31     -2270.37      -666.62      -564.05
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2270.37 kN-m.
           -. End Moments (My2) =     3018.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -3018.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -3018.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      564.05 kN-m.
          -. End Moments (Mz2) =      666.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -666.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -666.62 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      3368.774 kN.
          -. Mry        =      5073.356 kN-m.
          -. Mrz        =      1115.981 kN-m.
          -. Mr         =      5194.647 kN-m.
          -. Pu/Pr      =   0.598  --->  O.K !
          -. Muy/Mry    =   0.595  --->  O.K !
          -. Muz/Mrz    =   0.597  --->  O.K !
          -. Mu/Mr      =   0.598  --->  O.K !
          -. Ratio      =   0.598  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2013.70 kN.
          -. Vuz    =       1496.34 kN.
          -. Muy    =      -3018.31 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.16

          -. Vuy    =        384.99 kN.
          -. Muz    =       -666.62 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.07
```

( ). Compute shear strength of concrete.
-. Vuz = 1496.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 977.55 kN.
-. phiVcz = phi * Vcz = 879.80 kN.

-. Vuy = 384.99 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 934.77 kN.
-. phiVcy = phi * Vcy = 841.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1954.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6170.94 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1954.77 kN.
-. phiVsz = phi*Vsz = 1759.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1920.64 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6213.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1920.64 kN.
-. phiVsy = phi*Vsy = 1728.57 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1545.078 kN.
-. Vr = 2569.864 kN.
-. Ratio = Vu / Vr = 0.601 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1716.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1716.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0093 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0094 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0094 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118103,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2030.45     -2270.37     -1579.37      -564.05      -490.09
           ------------------------------------------------------------------------------
            DL+LL+Others     2030.45     -2270.37     -1579.37      -564.05      -490.09
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1579.37 kN-m.
           -. End Moments (My2) =     2270.37 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -2270.37 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -2270.37 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      490.09 kN-m.
          -. End Moments (Mz2) =      564.05 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -564.05 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -564.05 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      4491.740 kN.
          -. Mry        =      5063.429 kN-m.
          -. Mrz        =      1257.422 kN-m.
          -. Mr         =      5217.223 kN-m.
          -. Pu/Pr      =   0.452  --->  O.K !
          -. Muy/Mry    =   0.448  --->  O.K !
          -. Muz/Mrz    =   0.449  --->  O.K !
          -. Mu/Mr      =   0.452  --->  O.K !
          -. Ratio      =   0.452  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2030.45 kN.
          -. Vuz    =       1382.53 kN.
          -. Muy    =      -2270.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.37

          -. Vuy    =        350.61 kN.
          -. Muz    =       -564.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.28
```

( ). Compute shear strength of concrete.
-. Vuz = 1382.53 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1071.69 kN.
-. phiVcz = phi * Vcz = 964.52 kN.

-. Vuy = 350.61 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1028.35 kN.
-. phiVcy = phi * Vcy = 925.51 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2022.64 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6076.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2022.64 kN.
-. phiVsz = phi*Vsz = 1820.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1992.55 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6120.14 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1992.55 kN.
-. phiVsy = phi*Vsy = 1793.29 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1426.298 kN.
-. Vr = 2718.804 kN.
-. Ratio = Vu / Vr = 0.525 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1584.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1584.78 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0068 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0069 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0069 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118104,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2047.19     -1579.37      -947.26      -490.09      -483.19
           ------------------------------------------------------------------------------
            DL+LL+Others     2047.19     -1579.37      -947.26      -490.09      -483.19
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      947.26 kN-m.
           -. End Moments (My2) =     1579.37 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1579.37 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1579.37 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      483.19 kN-m.
          -. End Moments (Mz2) =      490.09 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -490.09 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -490.09 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      6377.523 kN.
          -. Mry        =      4951.978 kN-m.
          -. Mrz        =      1527.210 kN-m.
          -. Mr         =      5182.128 kN-m.
          -. Pu/Pr      =   0.321  --->  O.K !
          -. Muy/Mry    =   0.319  --->  O.K !
          -. Muz/Mrz    =   0.321  --->  O.K !
          -. Mu/Mr      =   0.321  --->  O.K !
          -. Ratio      =   0.321  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2047.19 kN.
          -. Vuz    =       1265.08 kN.
          -. Muy    =      -1579.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.60

          -. Vuy    =        315.67 kN.
          -. Muz    =       -490.09 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51
```

( ). Compute shear strength of concrete.
-. Vuz = 1265.08 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1176.61 kN.
-. phiVcz = phi * Vcz = 1058.95 kN.

-. Vuy = 315.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1133.40 kN.
-. phiVcy = phi * Vcy = 1020.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2088.41 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5971.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2088.41 kN.
-. phiVsz = phi*Vsz = 1879.57 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2062.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6015.08 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2062.45 kN.
-. phiVsy = phi*Vsy = 1856.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1303.868 kN.
-. Vr = 2876.269 kN.
-. Ratio = Vu / Vr = 0.453 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1448.74 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1448.74 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118105,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2063.94      -947.26      -375.92      -483.19      -535.53
           ------------------------------------------------------------------------------
            DL+LL+Others     2063.94      -947.26      -375.92      -483.19      -535.53
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      375.92 kN-m.
           -. End Moments (My2) =      947.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -947.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -947.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      483.19 kN-m.
          -. End Moments (Mz2) =      535.53 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -483.19 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -483.19 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9503.547 kN.
          -. Mry        =      4344.841 kN-m.
          -. Mrz        =      2212.435 kN-m.
          -. Mr         =      4875.706 kN-m.
          -. Pu/Pr      =   0.217  --->  O.K !
          -. Muy/Mry    =   0.218  --->  O.K !
          -. Muz/Mrz    =   0.218  --->  O.K !
          -. Mu/Mr      =   0.218  --->  O.K !
          -. Ratio      =   0.218  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2063.94 kN.
          -. Vuz    =       1145.22 kN.
          -. Muy    =       -947.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.85

          -. Vuy    =        280.57 kN.
          -. Muz    =       -483.19 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 1145.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1287.65 kN.
-. phiVcz = phi * Vcz = 1158.88 kN.

-. Vuy = 280.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1245.48 kN.
-. phiVcy = phi * Vcy = 1120.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2148.87 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5860.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2148.87 kN.
-. phiVsz = phi*Vsz = 1933.98 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2126.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5903.00 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2126.90 kN.
-. phiVsy = phi*Vsy = 1914.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1179.091 kN.
-. Vr = 3035.147 kN.
-. Ratio = Vu / Vr = 0.388 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1310.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1310.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0025 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118106,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2623.88      -337.99      -264.29      -540.54      -676.36
           ------------------------------------------------------------------------------
            DL+LL+Others     2623.88      -337.99      -264.29      -540.54      -676.36
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      264.29 kN-m.
           -. End Moments (My2) =      337.99 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -264.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -264.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      540.54 kN-m.
          -. End Moments (Mz2) =      676.36 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -676.36 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -676.36 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15365.878 kN.
          -. Mry        =      1538.164 kN-m.
          -. Mrz        =      3949.310 kN-m.
          -. Mr         =      4238.278 kN-m.
          -. Pu/Pr      =   0.171  --->  O.K !
          -. Muy/Mry    =   0.172  --->  O.K !
          -. Muz/Mrz    =   0.171  --->  O.K !
          -. Mu/Mr      =   0.172  --->  O.K !
          -. Ratio      =   0.172  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2097.33 kN.
          -. Vuz    =       1024.31 kN.
          -. Muy    =       -424.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        245.74 kN.
          -. Muz    =       -581.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86
```

( ). Compute shear strength of concrete.
-. Vuz = 1024.31 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1332.69 kN.
-. phiVcz = phi * Vcz = 1199.42 kN.

-. Vuy = 245.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1291.22 kN.
-. phiVcy = phi * Vcy = 1162.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2171.13 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5815.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2171.13 kN.
-. phiVsz = phi*Vsz = 1954.02 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2150.68 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5857.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2150.68 kN.
-. phiVsy = phi*Vsy = 1935.61 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1053.378 kN.
-. Vr = 3097.710 kN.
-. Ratio = Vu / Vr = 0.340 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1170.42 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1170.42 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118107,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2114.07      -424.68      -813.08      -581.35      -620.01
           ------------------------------------------------------------------------------
            DL+LL+Others     2114.07      -424.68      -813.08      -581.35      -620.01
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      424.68 kN-m.
           -. End Moments (My2) =      813.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -813.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -813.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      581.35 kN-m.
          -. End Moments (Mz2) =      620.01 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -620.01 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -620.01 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9964.848 kN.
          -. Mry        =      3840.449 kN-m.
          -. Mrz        =      2930.978 kN-m.
          -. Mr         =      4831.116 kN-m.
          -. Pu/Pr      =   0.212  --->  O.K !
          -. Muy/Mry    =   0.212  --->  O.K !
          -. Muz/Mrz    =   0.212  --->  O.K !
          -. Mu/Mr      =   0.212  --->  O.K !
          -. Ratio      =   0.212  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2114.07 kN.
          -. Vuz    =        903.71 kN.
          -. Muy    =       -813.08 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        211.66 kN.
          -. Muz    =       -620.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.85
```

( ). Compute shear strength of concrete.
-. Vuz = 903.71 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1330.55 kN.
-. phiVcz = phi * Vcz = 1197.49 kN.

-. Vuy = 211.66 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1289.03 kN.
-. phiVcy = phi * Vcy = 1160.13 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2170.10 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5817.94 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2170.10 kN.
-. phiVsz = phi*Vsz = 1953.09 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2149.58 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5859.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2149.58 kN.
-. phiVsy = phi*Vsy = 1934.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 928.161 kN.
-. Vr = 3094.749 kN.
-. Ratio = Vu / Vr = 0.300 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1031.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1031.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118108,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2130.81      -813.08     -1150.00      -620.01      -647.58
           ------------------------------------------------------------------------------
            DL+LL+Others     2130.81      -813.08     -1150.00      -620.01      -647.58
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      813.08 kN-m.
           -. End Moments (My2) =     1150.00 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1150.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1150.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      620.01 kN-m.
          -. End Moments (Mz2) =      647.58 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -647.58 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -647.58 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8081.047 kN.
          -. Mry        =      4383.301 kN-m.
          -. Mrz        =      2469.561 kN-m.
          -. Mr         =      5031.109 kN-m.
          -. Pu/Pr      =   0.264  --->  O.K !
          -. Muy/Mry    =   0.262  --->  O.K !
          -. Muz/Mrz    =   0.262  --->  O.K !
          -. Mu/Mr      =   0.264  --->  O.K !
          -. Ratio      =   0.264  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2130.81 kN.
          -. Vuz    =        784.87 kN.
          -. Muy    =      -1150.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        178.84 kN.
          -. Muz    =       -647.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.41 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.77
```

( ). Compute shear strength of concrete.
-. Vuz = 784.87 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1294.35 kN.
-. phiVcz = phi * Vcz = 1164.92 kN.

-. Vuy = 178.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1252.28 kN.
-. phiVcy = phi * Vcy = 1127.05 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2152.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5854.13 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2152.26 kN.
-. phiVsz = phi*Vsz = 1937.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2130.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5896.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2130.52 kN.
-. phiVsy = phi*Vsy = 1917.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 804.986 kN.
-. Vr = 3044.524 kN.
-. Ratio = Vu / Vr = 0.264 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 894.43 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 894.43 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118109,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2147.54     -1150.00     -1434.85      -647.58      -664.22
           ------------------------------------------------------------------------------
            DL+LL+Others     2147.54     -1150.00     -1434.85      -647.58      -664.22
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1150.00 kN-m.
           -. End Moments (My2) =     1434.85 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1434.85 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1434.85 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      647.58 kN-m.
          -. End Moments (Mz2) =      664.22 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -664.22 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -664.22 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      6982.337 kN.
          -. Mry        =      4668.571 kN-m.
          -. Mrz        =      2166.545 kN-m.
          -. Mr         =      5146.793 kN-m.
          -. Pu/Pr      =   0.308  --->  O.K !
          -. Muy/Mry    =   0.307  --->  O.K !
          -. Muz/Mrz    =   0.307  --->  O.K !
          -. Mu/Mr      =   0.308  --->  O.K !
          -. Ratio      =   0.308  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2147.54 kN.
          -. Vuz    =        669.24 kN.
          -. Muy    =      -1434.85 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =        148.01 kN.
          -. Muz    =       -664.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 669.24 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1265.63 kN.
-. phiVcz = phi * Vcz = 1139.07 kN.

-. Vuy = 148.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1223.19 kN.
-. phiVcy = phi * Vcy = 1100.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2137.54 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5882.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2137.54 kN.
-. phiVsz = phi*Vsz = 1923.79 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2114.81 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5925.30 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2114.81 kN.
-. phiVsy = phi*Vsy = 1903.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 685.412 kN.
-. Vr = 3004.200 kN.
-. Ratio = Vu / Vr = 0.228 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 761.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 761.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                  Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118110,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2164.27     -1434.85     -1668.88      -664.22      -670.63
           ------------------------------------------------------------------------------
            DL+LL+Others     2164.27     -1434.85     -1668.88      -664.22      -670.63
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1434.85 kN-m.
           -. End Moments (My2) =     1668.88 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1668.88 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1668.88 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      664.22 kN-m.
          -. End Moments (Mz2) =      670.63 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -670.63 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -670.63 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      6200.518 kN.
          -. Mry        =      4818.969 kN-m.
          -. Mrz        =      1937.433 kN-m.
          -. Mr         =      5193.853 kN-m.
          -. Pu/Pr      =   0.349  --->  O.K !
          -. Muy/Mry    =   0.346  --->  O.K !
          -. Muz/Mrz    =   0.346  --->  O.K !
          -. Mu/Mr      =   0.349  --->  O.K !
          -. Ratio      =   0.349  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2164.27 kN.
          -. Vuz    =        558.27 kN.
          -. Muy    =      -1668.88 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =        120.27 kN.
          -. Muz    =       -670.63 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.66
```

( ). Compute shear strength of concrete.
-. Vuz = 558.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1244.59 kN.
-. phiVcz = phi * Vcz = 1120.14 kN.

-. Vuy = 120.27 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1201.92 kN.
-. phiVcy = phi * Vcy = 1081.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2126.43 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5903.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2126.43 kN.
-. phiVsz = phi*Vsz = 1913.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2102.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5946.57 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2102.95 kN.
-. phiVsy = phi*Vsy = 1892.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 571.076 kN.
-. Vr = 2974.384 kN.
-. Ratio = Vu / Vr = 0.192 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 634.53 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 634.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118111,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            261.99      1619.48      1832.02       648.86       677.82
           ---------------------------------------------------------------------------
            DL+LL+Others      261.99      1619.48      1832.02       648.86       677.82
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1619.48 kN-m.
           -. End Moments (My2) =     1832.02 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1832.02 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1832.02 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      648.86 kN-m.
          -. End Moments (Mz2) =      677.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      677.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      677.82 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       671.941 kN.
          -. Mry        =      4716.443 kN-m.
          -. Mrz        =      1752.431 kN-m.
          -. Mr         =      5031.486 kN-m.
          -. Pu/Pr      =   0.390  --->  O.K !
          -. Muy/Mry    =   0.388  --->  O.K !
          -. Muz/Mrz    =   0.387  --->  O.K !
          -. Mu/Mr      =   0.390  --->  O.K !
          -. Ratio      =   0.390  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2180.99 kN.
          -. Vuz    =        453.36 kN.
          -. Muy    =      -1854.64 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.72

          -. Vuy    =         97.47 kN.
          -. Muz    =       -669.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.86 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.63
```

( ). Compute shear strength of concrete.
-. Vuz = 453.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1230.36 kN.
-. phiVcz = phi * Vcz = 1107.32 kN.

-. Vuy = 97.47 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1187.54 kN.
-. phiVcy = phi * Vcy = 1068.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2118.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5918.13 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2118.73 kN.
-. phiVsz = phi*Vsz = 1906.86 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2094.75 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5960.94 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2094.75 kN.
-. phiVsy = phi*Vsy = 1885.28 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 463.717 kN.
-. Vr = 2954.065 kN.
-. Ratio = Vu / Vr = 0.157 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 515.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 515.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118112,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            273.91      1832.02      2002.86       677.82       698.19
           ------------------------------------------------------------------------------
            DL+LL+Others      273.91      1832.02      2002.86       677.82       698.19
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1832.02 kN-m.
           -. End Moments (My2) =     2002.86 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2002.86 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2002.86 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      677.82 kN-m.
          -. End Moments (Mz2) =      698.19 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      698.19 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      698.19 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       652.920 kN.
          -. Mry        =      4748.312 kN-m.
          -. Mrz        =      1659.332 kN-m.
          -. Mr         =      5029.895 kN-m.
          -. Pu/Pr      =   0.420  --->  O.K !
          -. Muy/Mry    =   0.422  --->  O.K !
          -. Muz/Mrz    =   0.421  --->  O.K !
          -. Mu/Mr      =   0.422  --->  O.K !
          -. Ratio      =   0.422  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2197.72 kN.
          -. Vuz    =        355.85 kN.
          -. Muy    =      -2001.29 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =         81.11 kN.
          -. Muz    =       -663.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61
```

( ). Compute shear strength of concrete.
-. Vuz = 355.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1221.05 kN.
-. phiVcz = phi * Vcz = 1098.94 kN.

-. Vuy = 81.11 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1178.15 kN.
-. phiVcy = phi * Vcy = 1060.33 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2113.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5927.44 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2113.63 kN.
-. phiVsz = phi*Vsz = 1902.27 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2089.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5970.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2089.31 kN.
-. phiVsy = phi*Vsy = 1880.38 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 364.982 kN.
-. Vr = 2940.714 kN.
-. Ratio = Vu / Vr = 0.124 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 405.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 405.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118113,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            285.84      2002.86      2115.68       698.19       703.03
           ------------------------------------------------------------------------------
            DL+LL+Others      285.84      2002.86      2115.68       698.19       703.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2002.86 kN-m.
           -. End Moments (My2) =     2115.68 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2115.68 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2115.68 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      698.19 kN-m.
          -. End Moments (Mz2) =      703.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      703.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      703.03 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       648.046 kN.
          -. Mry        =      4772.491 kN-m.
          -. Mrz        =      1587.542 kN-m.
          -. Mr         =      5029.608 kN-m.
          -. Pu/Pr      =   0.441  --->  O.K !
          -. Muy/Mry    =   0.443  --->  O.K !
          -. Muz/Mrz    =   0.443  --->  O.K !
          -. Mu/Mr      =   0.443  --->  O.K !
          -. Ratio      =   0.443  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2214.44 kN.
          -. Vuz    =        227.00 kN.
          -. Muy    =      -2093.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71

          -. Vuy    =         66.51 kN.
          -. Muz    =       -645.75 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.90 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.62
```

( ). Compute shear strength of concrete.
-. Vuz = 227.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1224.39 kN.
-. phiVcz = phi * Vcz = 1101.95 kN.

-. Vuy = 66.51 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1181.52 kN.
-. phiVcy = phi * Vcy = 1063.37 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2115.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5924.09 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2115.47 kN.
-. phiVsz = phi*Vsz = 1903.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2091.27 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5966.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2091.27 kN.
-. phiVsy = phi*Vsy = 1882.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 236.546 kN.
-. Vr = 2945.519 kN.
-. Ratio = Vu / Vr = 0.080 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 262.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 262.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118114,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            297.77      2115.68      2154.88       703.03       690.88
           ------------------------------------------------------------------------------
            DL+LL+Others      297.77      2115.68      2154.88       703.03       690.88
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2115.68 kN-m.
           -. End Moments (My2) =     2154.88 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2154.88 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2154.88 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      690.88 kN-m.
          -. End Moments (Mz2) =      703.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      690.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      690.88 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       658.424 kN.
          -. Mry        =      4790.366 kN-m.
          -. Mrz        =      1536.088 kN-m.
          -. Mr         =      5030.624 kN-m.
          -. Pu/Pr      =   0.452  --->  O.K !
          -. Muy/Mry    =   0.450  --->  O.K !
          -. Muz/Mrz    =   0.450  --->  O.K !
          -. Mu/Mr      =   0.452  --->  O.K !
          -. Ratio      =   0.452  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2231.16 kN.
          -. Vuz    =         78.90 kN.
          -. Muy    =      -2116.73 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =         70.10 kN.
          -. Muz    =       -617.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 78.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1239.20 kN.
-. phiVcz = phi * Vcz = 1115.28 kN.

-. Vuy = 70.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1196.47 kN.
-. phiVcy = phi * Vcy = 1076.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2123.53 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5909.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2123.53 kN.
-. phiVsz = phi*Vsz = 1911.18 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2099.86 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5952.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2099.86 kN.
-. phiVsy = phi*Vsy = 1889.88 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 105.543 kN.
-. Vr = 2966.702 kN.
-. Ratio = Vu / Vr = 0.036 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 117.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 117.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118115,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            297.71      2154.88      2130.57       690.88       663.64
           ---------------------------------------------------------------------------
            DL+LL+Others      297.71      2154.88      2130.57       690.88       663.64
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2130.57 kN-m.
           -. End Moments (My2) =     2154.88 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2154.88 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2154.88 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      663.64 kN-m.
          -. End Moments (Mz2) =      690.88 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      690.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      690.88 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       658.424 kN.
          -. Mry        =      4790.366 kN-m.
          -. Mrz        =      1536.088 kN-m.
          -. Mr         =      5030.624 kN-m.
          -. Pu/Pr      =   0.452  --->  O.K !
          -. Muy/Mry    =   0.450  --->  O.K !
          -. Muz/Mrz    =   0.450  --->  O.K !
          -. Mu/Mr      =   0.452  --->  O.K !
          -. Ratio      =   0.452  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2231.22 kN.
          -. Vuz    =         85.19 kN.
          -. Muy    =      -2116.73 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =         85.72 kN.
          -. Muz    =       -617.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 85.19 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1237.05 kN.
-. phiVcz = phi * Vcz = 1113.34 kN.

-. Vuy = 85.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1194.29 kN.
-. phiVcy = phi * Vcy = 1074.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2122.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5911.44 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2122.36 kN.
-. phiVsz = phi*Vsz = 1910.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2098.62 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5954.19 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2098.62 kN.
-. phiVsy = phi*Vsy = 1888.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 120.856 kN.
-. Vr = 2963.626 kN.
-. Ratio = Vu / Vr = 0.041 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 134.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 134.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118116,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            309.65      2130.57      2053.88       663.64       625.60
           ---------------------------------------------------------------------------
            DL+LL+Others      309.65      2130.57      2053.88       663.64       625.60
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2053.88 kN-m.
           -. End Moments (My2) =     2130.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2130.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2130.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      625.60 kN-m.
          -. End Moments (Mz2) =      663.64 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      663.64 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      663.64 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       698.770 kN.
          -. Mry        =      4806.411 kN-m.
          -. Mrz        =      1497.050 kN-m.
          -. Mr         =      5034.158 kN-m.
          -. Pu/Pr      =   0.443  --->  O.K !
          -. Muy/Mry    =   0.443  --->  O.K !
          -. Muz/Mrz    =   0.443  --->  O.K !
          -. Mu/Mr      =   0.443  --->  O.K !
          -. Ratio      =   0.443  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2247.93 kN.
          -. Vuz    =        177.57 kN.
          -. Muy    =      -2080.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73

          -. Vuy    =         97.87 kN.
          -. Muz    =       -578.66 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.63
```

( ). Compute shear strength of concrete.
-. Vuz = 177.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1231.77 kN.
-. phiVcz = phi * Vcz = 1108.60 kN.

-. Vuy = 97.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1188.97 kN.
-. phiVcy = phi * Vcy = 1070.08 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2119.51 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5916.71 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2119.51 kN.
-. phiVsz = phi*Vsz = 1907.56 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2095.58 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5959.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2095.58 kN.
-. phiVsy = phi*Vsy = 1886.02 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 202.751 kN.
-. Vr = 2956.094 kN.
-. Ratio = Vu / Vr = 0.069 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 225.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 225.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118117,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            321.58      2053.88      1936.09       625.60       578.21
           ------------------------------------------------------------------------------
            DL+LL+Others      321.58      2053.88      1936.09       625.60       578.21
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1936.09 kN-m.
           -. End Moments (My2) =     2053.88 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2053.88 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2053.88 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      578.21 kN-m.
          -. End Moments (Mz2) =      625.60 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      625.60 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      625.60 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       754.263 kN.
          -. Mry        =      4820.161 kN-m.
          -. Mrz        =      1468.602 kN-m.
          -. Mr         =      5038.923 kN-m.
          -. Pu/Pr      =   0.426  --->  O.K !
          -. Muy/Mry    =   0.426  --->  O.K !
          -. Muz/Mrz    =   0.426  --->  O.K !
          -. Mu/Mr      =   0.426  --->  O.K !
          -. Ratio      =   0.426  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2264.64 kN.
          -. Vuz    =        249.41 kN.
          -. Muy    =      -1995.73 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =        105.43 kN.
          -. Muz    =       -533.95 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 249.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1236.23 kN.
-. phiVcz = phi * Vcz = 1112.61 kN.

-. Vuy = 105.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1193.47 kN.
-. phiVcy = phi * Vcy = 1074.12 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2121.92 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5912.26 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2121.92 kN.
-. phiVsz = phi*Vsz = 1909.73 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2098.15 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5955.02 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2098.15 kN.
-. phiVsy = phi*Vsy = 1888.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 270.782 kN.
-. Vr = 2962.460 kN.
-. Ratio = Vu / Vr = 0.091 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 300.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 300.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118118,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            333.52      1936.09      1788.22       578.21       524.58
           ------------------------------------------------------------------------------
            DL+LL+Others      333.52      1936.09      1788.22       578.21       524.58
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1788.22 kN-m.
           -. End Moments (My2) =     1936.09 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1936.09 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1936.09 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      524.58 kN-m.
          -. End Moments (Mz2) =      578.21 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      578.21 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      578.21 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       828.793 kN.
          -. Mry        =      4833.800 kN-m.
          -. Mrz        =      1445.260 kN-m.
          -. Mr         =      5045.236 kN-m.
          -. Pu/Pr      =   0.402  --->  O.K !
          -. Muy/Mry    =   0.401  --->  O.K !
          -. Muz/Mrz    =   0.400  --->  O.K !
          -. Mu/Mr      =   0.402  --->  O.K !
          -. Ratio      =   0.402  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2281.35 kN.
          -. Vuz    =        300.81 kN.
          -. Muy    =      -1873.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.77

          -. Vuy    =        108.88 kN.
          -. Muz    =       -483.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67
```

( ). Compute shear strength of concrete.
-. Vuz = 300.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1249.60 kN.
-. phiVcz = phi * Vcz = 1124.64 kN.

-. Vuy = 108.88 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1206.98 kN.
-. phiVcy = phi * Vcy = 1086.28 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2129.10 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5898.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2129.10 kN.
-. phiVsz = phi*Vsz = 1916.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2105.80 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5941.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2105.80 kN.
-. phiVsy = phi*Vsy = 1895.22 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 319.909 kN.
-. Vr = 2981.502 kN.
-. Ratio = Vu / Vr = 0.107 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 355.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 355.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118119,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                           -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            345.47      1788.22      1620.70       524.58       467.59
           ---------------------------------------------------------------------------
            DL+LL+Others      345.47      1788.22      1620.70       524.58       467.59
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1620.70 kN-m.
           -. End Moments (My2) =     1788.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1788.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1788.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      467.59 kN-m.
          -. End Moments (Mz2) =      524.58 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      524.58 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      524.58 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       938.192 kN.
          -. Mry        =      4848.902 kN-m.
          -. Mrz        =      1426.497 kN-m.
          -. Mr         =      5054.378 kN-m.
          -. Pu/Pr      =   0.368  --->  O.K !
          -. Muy/Mry    =   0.369  --->  O.K !
          -. Muz/Mrz    =   0.368  --->  O.K !
          -. Mu/Mr      =   0.369  --->  O.K !
          -. Ratio      =   0.369  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2298.05 kN.
          -. Vuz    =        334.09 kN.
          -. Muy    =      -1723.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.30 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81

          -. Vuy    =        109.02 kN.
          -. Muz    =       -430.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.57 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.72
```

( ). Compute shear strength of concrete.
-. Vuz = 334.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1270.44 kN.
-. phiVcz = phi * Vcz = 1143.40 kN.

-. Vuy = 109.02 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1228.06 kN.
-. phiVcy = phi * Vcy = 1105.25 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2140.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5878.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2140.04 kN.
-. phiVsz = phi*Vsz = 1926.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2117.48 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5920.43 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2117.48 kN.
-. phiVsy = phi*Vsy = 1905.73 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 351.430 kN.
-. Vr = 3010.987 kN.
-. Ratio = Vu / Vr = 0.117 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 390.48 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 390.48 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118120,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            357.41      1620.70      1443.12       467.59       409.86
           ---------------------------------------------------------------------------
            DL+LL+Others      357.41      1620.70      1443.12       467.59       409.86
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1443.12 kN-m.
           -. End Moments (My2) =     1620.70 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1620.70 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1620.70 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      409.86 kN-m.
          -. End Moments (Mz2) =      467.59 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      467.59 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      467.59 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1083.100 kN.
          -. Mry        =      4865.726 kN-m.
          -. Mrz        =      1411.529 kN-m.
          -. Mr         =      5066.330 kN-m.
          -. Pu/Pr      =   0.330  --->  O.K !
          -. Muy/Mry    =   0.333  --->  O.K !
          -. Muz/Mrz    =   0.331  --->  O.K !
          -. Mu/Mr      =   0.333  --->  O.K !
          -. Ratio      =   0.333  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2314.76 kN.
          -. Vuz    =        350.36 kN.
          -. Muy    =      -1556.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.87

          -. Vuy    =        105.59 kN.
          -. Muz    =       -377.18 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.78
```

( ). Compute shear strength of concrete.
-. Vuz = 350.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1297.60 kN.
-. phiVcz = phi * Vcz = 1167.84 kN.

-. Vuy = 105.59 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1255.58 kN.
-. phiVcy = phi * Vcy = 1130.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2153.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5850.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2153.89 kN.
-. phiVsz = phi*Vsz = 1938.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2132.27 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5892.91 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2132.27 kN.
-. phiVsy = phi*Vsy = 1919.04 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 365.930 kN.
-. Vr = 3049.059 kN.
-. Ratio = Vu / Vr = 0.120 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 406.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 406.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118121,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            369.36      1443.12      1264.08       409.86       353.68
           ------------------------------------------------------------------------------
            DL+LL+Others      369.36      1443.12      1264.08       409.86       353.68
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1264.08 kN-m.
           -. End Moments (My2) =     1443.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1443.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1443.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      353.68 kN-m.
          -. End Moments (Mz2) =      409.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      409.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      409.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1257.589 kN.
          -. Mry        =      4883.609 kN-m.
          -. Mrz        =      1395.749 kN-m.
          -. Mr         =      5079.149 kN-m.
          -. Pu/Pr      =   0.294  --->  O.K !
          -. Muy/Mry    =   0.296  --->  O.K !
          -. Muz/Mrz    =   0.294  --->  O.K !
          -. Mu/Mr      =   0.296  --->  O.K !
          -. Ratio      =   0.296  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2331.46 kN.
          -. Vuz    =        350.39 kN.
          -. Muy    =      -1381.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.94

          -. Vuy    =         99.07 kN.
          -. Muz    =       -324.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.85
```

( ). Compute shear strength of concrete.
-. Vuz = 350.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1329.99 kN.
-. phiVcz = phi * Vcz = 1196.99 kN.

-. Vuy = 99.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1288.47 kN.
-. phiVcy = phi * Vcy = 1159.62 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2169.83 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5818.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2169.83 kN.
-. phiVsz = phi*Vsz = 1952.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2149.29 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5860.02 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2149.29 kN.
-. phiVsy = phi*Vsy = 1934.36 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 364.128 kN.
-. Vr = 3093.980 kN.
-. Ratio = Vu / Vr = 0.118 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 404.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 404.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118122,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            381.31      1264.08      1091.03       353.68       301.01
           ---------------------------------------------------------------------------
            DL+LL+Others      381.31      1264.08      1091.03       353.68       301.01
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1091.03 kN-m.
           -. End Moments (My2) =     1264.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1264.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1264.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      301.01 kN-m.
          -. End Moments (Mz2) =      353.68 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      353.68 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      353.68 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1487.953 kN.
          -. Mry        =      4904.214 kN-m.
          -. Mrz        =      1378.189 kN-m.
          -. Mr         =      5094.184 kN-m.
          -. Pu/Pr      =   0.256  --->  O.K !
          -. Muy/Mry    =   0.258  --->  O.K !
          -. Muz/Mrz    =   0.257  --->  O.K !
          -. Mu/Mr      =   0.258  --->  O.K !
          -. Ratio      =   0.258  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2348.15 kN.
          -. Vuz    =        336.36 kN.
          -. Muy    =      -1206.01 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.74 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.02

          -. Vuy    =         90.14 kN.
          -. Muz    =       -275.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.97 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.93
```

( ). Compute shear strength of concrete.
-. Vuz = 336.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1366.30 kN.
-. phiVcz = phi * Vcz = 1229.67 kN.

-. Vuy = 90.14 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1325.43 kN.
-. phiVcy = phi * Vcy = 1192.89 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2186.98 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5782.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2186.98 kN.
-. phiVsz = phi*Vsz = 1968.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2167.63 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5823.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2167.63 kN.
-. phiVsy = phi*Vsy = 1950.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 348.226 kN.
-. Vr = 3143.756 kN.
-. Ratio = Vu / Vr = 0.111 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 386.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 386.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118123,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2364.85     -1037.83      -881.90      -230.44      -190.69
           ---------------------------------------------------------------------------
            DL+LL+Others     2364.85     -1037.83      -881.90      -230.44      -190.69
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      881.90 kN-m.
           -. End Moments (My2) =     1037.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1037.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1037.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      190.69 kN-m.
          -. End Moments (Mz2) =      230.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -230.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -230.44 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10556.647 kN.
          -. Mry        =      4672.683 kN-m.
          -. Mrz        =      1034.386 kN-m.
          -. Mr         =      4785.804 kN-m.
          -. Pu/Pr      =   0.224  --->  O.K !
          -. Muy/Mry    =   0.222  --->  O.K !
          -. Muz/Mrz    =   0.223  --->  O.K !
          -. Mu/Mr      =   0.224  --->  O.K !
          -. Ratio      =   0.224  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2364.85 kN.
          -. Vuz    =        311.86 kN.
          -. Muy    =      -1037.83 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.54 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.11

          -. Vuy    =         79.63 kN.
          -. Muz    =       -230.44 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.02
```

( ). Compute shear strength of concrete.
-. Vuz = 311.86 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1404.89 kN.
-. phiVcz = phi * Vcz = 1264.40 kN.

-. Vuy = 79.63 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1364.84 kN.
-. phiVcy = phi * Vcy = 1228.35 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2204.44 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5743.60 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2204.44 kN.
-. phiVsz = phi*Vsz = 1984.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2186.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5783.65 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2186.31 kN.
-. phiVsy = phi*Vsy = 1967.68 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 321.869 kN.
-. Vr = 3196.029 kN.
-. Ratio = Vu / Vr = 0.101 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 357.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 357.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118124,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2381.54      -881.90      -737.78      -190.69      -155.20
           ------------------------------------------------------------------------------
            DL+LL+Others     2381.54      -881.90      -737.78      -190.69      -155.20
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      737.78 kN-m.
           -. End Moments (My2) =      881.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -881.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -881.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      155.20 kN-m.
          -. End Moments (Mz2) =      190.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -190.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -190.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     12201.782 kN.
           -. Mry        =      4517.359 kN-m.
           -. Mrz        =       986.048 kN-m.
           -. Mr         =      4623.724 kN-m.
           -. Pu/Pr      =   0.195  --->  O.K !
           -. Muy/Mry    =   0.195  --->  O.K !
           -. Muz/Mrz    =   0.193  --->  O.K !
           -. Mu/Mr      =   0.195  --->  O.K !
           -. Ratio      =   0.195  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2381.54 kN.
           -. Vuz    =        288.24 kN.
           -. Muy    =       -881.90 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.35 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.19

           -. Vuy    =         71.12 kN.
           -. Muz    =       -190.69 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.54 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.11
```

( ). Compute shear strength of concrete.
-. Vuz = 288.24 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1442.56 kN.
-. phiVcz = phi * Vcz = 1298.30 kN.

-. Vuy = 71.12 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1403.40 kN.
-. phiVcy = phi * Vcy = 1263.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2220.76 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5705.93 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2220.76 kN.
-. phiVsz = phi*Vsz = 1998.69 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2203.78 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5745.08 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2203.78 kN.
-. phiVsy = phi*Vsy = 1983.41 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 296.888 kN.
-. Vr = 3246.469 kN.
-. Ratio = Vu / Vr = 0.091 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 329.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 329.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118125,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2398.23      -737.78      -607.44      -155.20      -124.17
           ------------------------------------------------------------------------------
            DL+LL+Others     2398.23      -737.78      -607.44      -155.20      -124.17
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      607.44 kN-m.
           -. End Moments (My2) =      737.78 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -737.78 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -737.78 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      124.17 kN-m.
          -. End Moments (Mz2) =      155.20 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -155.20 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -155.20 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14132.900 kN.
          -. Mry        =      4307.427 kN-m.
          -. Mrz        =       901.910 kN-m.
          -. Mr         =      4400.837 kN-m.
          -. Pu/Pr      =   0.170  --->  O.K !
          -. Muy/Mry    =   0.171  --->  O.K !
          -. Muz/Mrz    =   0.172  --->  O.K !
          -. Mu/Mr      =   0.172  --->  O.K !
          -. Ratio      =   0.172  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2398.23 kN.
          -. Vuz    =        260.68 kN.
          -. Muy    =       -737.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.28

          -. Vuy    =         62.15 kN.
          -. Muz    =       -155.20 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.19
```

( ). Compute shear strength of concrete.
-. Vuz = 260.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1480.18 kN.
-. phiVcz = phi * Vcz = 1332.17 kN.

-. Vuy = 62.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1442.04 kN.
-. phiVcy = phi * Vcy = 1297.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2236.40 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5668.30 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2236.40 kN.
-. phiVsz = phi*Vsz = 2012.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2220.54 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5706.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2220.54 kN.
-. phiVsy = phi*Vsy = 1998.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 267.992 kN.
-. Vr = 3296.324 kN.
-. Ratio = Vu / Vr = 0.081 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 297.77 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 297.77 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118126,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2414.91      -607.44      -492.05      -124.17       -97.69
           ------------------------------------------------------------------------------
            DL+LL+Others     2414.91      -607.44      -492.05      -124.17       -97.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      492.05 kN-m.
           -. End Moments (My2) =      607.44 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -607.44 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -607.44 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       97.69 kN-m.
          -. End Moments (Mz2) =      124.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -124.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -124.17 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     16051.509 kN.
          -. Mry        =      4054.867 kN-m.
          -. Mrz        =       834.129 kN-m.
          -. Mr         =      4139.773 kN-m.
          -. Pu/Pr      =   0.150  --->  O.K !
          -. Muy/Mry    =   0.150  --->  O.K !
          -. Muz/Mrz    =   0.149  --->  O.K !
          -. Mu/Mr      =   0.150  --->  O.K !
          -. Ratio      =   0.150  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2414.91 kN.
          -. Vuz    =        230.77 kN.
          -. Muy    =       -607.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.36

          -. Vuy    =         53.08 kN.
          -. Muz    =       -124.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.28
```

( ). Compute shear strength of concrete.
-. Vuz = 230.77 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1516.78 kN.
-. phiVcz = phi * Vcz = 1365.11 kN.

-. Vuy = 53.08 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1479.72 kN.
-. phiVcy = phi * Vcy = 1331.75 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2251.01 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5631.70 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2251.01 kN.
-. phiVsz = phi*Vsz = 2025.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2236.21 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5668.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2236.21 kN.
-. phiVsy = phi*Vsy = 2012.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 236.800 kN.
-. Vr = 3344.343 kN.
-. Ratio = Vu / Vr = 0.071 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 263.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 263.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118127,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2431.60      -492.05      -391.20       -97.69       -75.41
           ------------------------------------------------------------------------------
            DL+LL+Others     2431.60      -492.05      -391.20       -97.69       -75.41
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      391.20 kN-m.
           -. End Moments (My2) =      492.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -492.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -492.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       75.41 kN-m.
          -. End Moments (Mz2) =       97.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -97.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -97.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     18256.169 kN.
          -. Mry        =      3695.437 kN-m.
          -. Mrz        =       729.783 kN-m.
          -. Mr         =      3766.807 kN-m.
          -. Pu/Pr      =   0.133  --->  O.K !
          -. Muy/Mry    =   0.133  --->  O.K !
          -. Muz/Mrz    =   0.134  --->  O.K !
          -. Mu/Mr      =   0.134  --->  O.K !
          -. Ratio      =   0.134  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2431.60 kN.
          -. Vuz    =        201.71 kN.
          -. Muy    =       -492.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.43

          -. Vuy    =         44.71 kN.
          -. Muz    =        -97.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.35
```

( ). Compute shear strength of concrete.
-. Vuz = 201.71 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1551.03 kN.
-. phiVcz = phi * Vcz = 1395.93 kN.

-. Vuy = 44.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1515.08 kN.
-. phiVcy = phi * Vcy = 1363.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2264.18 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5597.45 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2264.18 kN.
-. phiVsz = phi*Vsz = 2037.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2250.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5633.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2250.34 kN.
-. phiVsy = phi*Vsy = 2025.31 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 206.605 kN.
-. Vr = 3388.882 kN.
-. Ratio = Vu / Vr = 0.061 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 229.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 229.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118128,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2976.13      -213.31      -163.76      -150.07      -112.83
           ------------------------------------------------------------------------------
            DL+LL+Others     2976.13      -213.31      -163.76      -150.07      -112.83
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      163.76 kN-m.
           -. End Moments (My2) =      213.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -213.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -213.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      112.83 kN-m.
          -. End Moments (Mz2) =      150.07 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -150.07 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -150.07 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =      1736.921 kN-m.
          -. Mrz        =      1220.825 kN-m.
          -. Mr         =      2123.042 kN-m.
          -. Pu/Pr      =   0.122  --->  O.K !
          -. Muy/Mry    =   0.123  --->  O.K !
          -. Muz/Mrz    =   0.123  --->  O.K !
          -. Mu/Mr      =   0.123  --->  O.K !
          -. Ratio      =   0.123  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2448.28 kN.
          -. Vuz    =        182.23 kN.
          -. Muy    =       -391.20 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.74 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.50

          -. Vuy    =         39.34 kN.
          -. Muz    =        -75.41 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.88 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.42
```

( ). Compute shear strength of concrete.
-. Vuz = 182.23 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1580.55 kN.
-. phiVcz = phi * Vcz = 1422.49 kN.

-. Vuy = 39.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1545.62 kN.
-. phiVcy = phi * Vcy = 1391.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2275.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5567.94 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2275.15 kN.
-. phiVsz = phi*Vsz = 2047.64 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2262.13 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5602.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2262.13 kN.
-. phiVsy = phi*Vsy = 2035.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 186.432 kN.
-. Vr = 3426.975 kN.
-. Ratio = Vu / Vr = 0.054 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 207.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 207.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118129,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3009.49      -163.76      -119.18      -112.83       -79.84
           ------------------------------------------------------------------------------
            DL+LL+Others     3009.49      -163.76      -119.18      -112.83       -79.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      119.18 kN-m.
           -. End Moments (My2) =      163.76 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -119.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -119.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       79.84 kN-m.
          -. End Moments (Mz2) =      112.83 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -79.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -79.84 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       967.179 kN-m.
          -. Mrz        =       646.440 kN-m.
          -. Mr         =      1163.323 kN-m.
          -. Pu/Pr      =   0.123  --->  O.K !
          -. Muy/Mry    =   0.123  --->  O.K !
          -. Muz/Mrz    =   0.124  --->  O.K !
          -. Mu/Mr      =   0.124  --->  O.K !
          -. Ratio      =   0.124  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2464.95 kN.
          -. Vuz    =        163.84 kN.
          -. Muy    =       -300.08 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.56

          -. Vuy    =         34.46 kN.
          -. Muz    =        -55.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.48
```

( ). Compute shear strength of concrete.
-. Vuz = 163.84 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1608.16 kN.
-. phiVcz = phi * Vcz = 1447.34 kN.

-. Vuy = 34.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1574.25 kN.
-. phiVcy = phi * Vcy = 1416.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2285.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5540.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2285.12 kN.
-. phiVsz = phi*Vsz = 2056.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2272.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5574.23 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2272.84 kN.
-. phiVsy = phi*Vsy = 2045.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 167.425 kN.
-. Vr = 3462.385 kN.
-. Ratio = Vu / Vr = 0.048 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 186.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 186.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118130,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3026.19      -119.18       -79.16       -79.84       -50.67
           ------------------------------------------------------------------------------
            DL+LL+Others     3026.19      -119.18       -79.16       -79.84       -50.67
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       79.16 kN-m.
           -. End Moments (My2) =      119.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -79.16 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -79.16 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       50.67 kN-m.
          -. End Moments (Mz2) =       79.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -50.67 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -50.67 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       638.069 kN-m.
          -. Mrz        =       409.160 kN-m.
          -. Mr         =       757.987 kN-m.
          -. Pu/Pr      =   0.124  --->  O.K !
          -. Muy/Mry    =   0.124  --->  O.K !
          -. Muz/Mrz    =   0.124  --->  O.K !
          -. Mu/Mr      =   0.124  --->  O.K !
          -. Ratio      =   0.124  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2481.63 kN.
          -. Vuz    =        147.01 kN.
          -. Muy    =       -218.16 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.62

          -. Vuy    =         30.15 kN.
          -. Muz    =        -38.63 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.54
```

( ). Compute shear strength of concrete.
-. Vuz = 147.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1633.65 kN.
-. phiVcz = phi * Vcz = 1470.28 kN.

-. Vuy = 30.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1600.74 kN.
-. phiVcy = phi * Vcy = 1440.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2294.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5514.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2294.08 kN.
-. phiVsz = phi*Vsz = 2064.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2282.47 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5547.74 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2282.47 kN.
-. phiVsy = phi*Vsy = 2054.22 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 150.072 kN.
-. Vr = 3494.892 kN.
-. Ratio = Vu / Vr = 0.043 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 166.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 166.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118131,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3042.88       -79.16       -47.03       -50.67       -27.95
           ------------------------------------------------------------------------------
            DL+LL+Others     3042.88       -79.16       -47.03       -50.67       -27.95
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       47.03 kN-m.
           -. End Moments (My2) =       79.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -47.03 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -47.03 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       27.95 kN-m.
          -. End Moments (Mz2) =       50.67 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -27.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -27.95 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       377.201 kN-m.
          -. Mrz        =       224.125 kN-m.
          -. Mr         =       438.762 kN-m.
          -. Pu/Pr      =   0.125  --->  O.K !
          -. Muy/Mry    =   0.125  --->  O.K !
          -. Muz/Mrz    =   0.125  --->  O.K !
          -. Mu/Mr      =   0.125  --->  O.K !
          -. Ratio      =   0.125  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2498.30 kN.
          -. Vuz    =        117.93 kN.
          -. Muy    =       -144.66 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.68

          -. Vuy    =         22.97 kN.
          -. Muz    =        -23.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.55 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 117.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1660.59 kN.
-. phiVcz = phi * Vcz = 1494.54 kN.

-. Vuy = 22.97 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1628.80 kN.
-. phiVcy = phi * Vcy = 1465.92 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2303.31 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5487.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2303.31 kN.
-. phiVsz = phi*Vsz = 2072.98 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2292.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5519.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2292.39 kN.
-. phiVsy = phi*Vsy = 2063.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 120.146 kN.
-. Vr = 3529.074 kN.
-. Ratio = Vu / Vr = 0.034 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 133.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 133.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                  Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118132,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3059.56       -47.03       -24.90       -27.95       -13.23
           ------------------------------------------------------------------------------
            DL+LL+Others     3059.56       -47.03       -24.90       -27.95       -13.23
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       24.90 kN-m.
           -. End Moments (My2) =       47.03 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -24.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -24.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       13.23 kN-m.
          -. End Moments (Mz2) =       27.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -13.23 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -13.23 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =       198.620 kN-m.
           -. Mrz        =       105.544 kN-m.
           -. Mr         =       224.921 kN-m.
           -. Pu/Pr      =   0.125  --->  O.K !
           -. Muy/Mry    =   0.125  --->  O.K !
           -. Muz/Mrz    =   0.125  --->  O.K !
           -. Mu/Mr      =   0.125  --->  O.K !
           -. Ratio      =   0.125  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2514.97 kN.
           -. Vuz    =         81.01 kN.
           -. Muy    =        -85.70 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  30.34 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.73

           -. Vuy    =         14.28 kN.
           -. Muz    =        -12.28 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  30.45 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.66
```

( ). Compute shear strength of concrete.
-. Vuz = 81.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1686.00 kN.
-. phiVcz = phi * Vcz = 1517.40 kN.

-. Vuy = 14.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1655.31 kN.
-. phiVcy = phi * Vcy = 1489.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2311.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5462.49 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2311.78 kN.
-. phiVsz = phi*Vsz = 2080.60 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2301.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5493.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2301.51 kN.
-. phiVsy = phi*Vsy = 2071.36 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 82.259 kN.
-. Vr = 3561.138 kN.
-. Ratio = Vu / Vr = 0.023 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 91.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 91.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118133,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3076.24       -24.90       -10.99       -13.23        -4.86
           ------------------------------------------------------------------------------
            DL+LL+Others     3076.24       -24.90       -10.99       -13.23        -4.86
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       10.99 kN-m.
           -. End Moments (My2) =       24.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -10.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -10.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.86 kN-m.
          -. End Moments (Mz2) =       13.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        87.123 kN-m.
          -. Mrz        =        38.624 kN-m.
          -. Mr         =        95.301 kN-m.
          -. Pu/Pr      =   0.126  --->  O.K !
          -. Muy/Mry    =   0.126  --->  O.K !
          -. Muz/Mrz    =   0.126  --->  O.K !
          -. Mu/Mr      =   0.126  --->  O.K !
          -. Ratio      =   0.126  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2548.29 kN.
          -. Vuz    =         50.77 kN.
          -. Muy    =        -19.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.28 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.77

          -. Vuy    =          7.64 kN.
          -. Muz    =         -1.89 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.70
```

( ). Compute shear strength of concrete.
-. Vuz = 50.77 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1702.61 kN.
-. phiVcz = phi * Vcz = 1532.35 kN.

-. Vuy = 7.64 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1672.66 kN.
-. phiVcy = phi * Vcy = 1505.39 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2317.21 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5445.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2317.21 kN.
-. phiVsz = phi*Vsz = 2085.49 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2307.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5475.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2307.36 kN.
-. phiVsy = phi*Vsy = 2076.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 51.344 kN.
-. Vr = 3582.012 kN.
-. Ratio = Vu / Vr = 0.014 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 57.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 57.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118134,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3092.91       -10.99        -3.44        -4.86        -1.04
           ------------------------------------------------------------------------------
            DL+LL+Others     3092.91       -10.99        -3.44        -4.86        -1.04
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.44 kN-m.
           -. End Moments (My2) =       10.99 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.44 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.44 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.04 kN-m.
          -. End Moments (Mz2) =        4.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.04 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.04 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        27.129 kN-m.
          -. Mrz        =         8.210 kN-m.
          -. Mr         =        28.344 kN-m.
          -. Pu/Pr      =   0.127  --->  O.K !
          -. Muy/Mry    =   0.127  --->  O.K !
          -. Muz/Mrz    =   0.127  --->  O.K !
          -. Mu/Mr      =   0.127  --->  O.K !
          -. Ratio      =   0.127  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        536.93 kN.
          -. Vuz    =         30.46 kN.
          -. Muy    =          7.27 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.48

          -. Vuy    =          6.66 kN.
          -. Muz    =          1.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.33 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.48
```

( ). Compute shear strength of concrete.
-. Vuz = 30.46 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 2024.35 kN.
-. phiVcz = phi * Vcz = 1821.92 kN.

-. Vuy = 6.66 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 2024.35 kN.
-. phiVcy = phi * Vcy = 1821.92 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2407.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5124.13 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2407.52 kN.
-. phiVsz = phi*Vsz = 2166.77 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2407.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5124.13 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2407.52 kN.
-. phiVsy = phi*Vsy = 2166.77 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 31.179 kN.
-. Vr = 3988.685 kN.
-. Ratio = Vu / Vr = 0.008 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 34.64 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 34.64 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118135,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3109.58        -3.44        -0.40        -1.04        -0.14
           ------------------------------------------------------------------------------
            DL+LL+Others     3109.58        -3.44        -0.40        -1.04        -0.14
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.40 kN-m.
           -. End Moments (My2) =        3.44 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.40 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.40 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.14 kN-m.
          -. End Moments (Mz2) =        1.04 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.14 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.14 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         3.116 kN-m.
          -. Mrz        =         1.097 kN-m.
          -. Mr         =         3.304 kN-m.
          -. Pu/Pr      =   0.127  --->  O.K !
          -. Muy/Mry    =   0.127  --->  O.K !
          -. Muz/Mrz    =   0.128  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        548.92 kN.
          -. Vuz    =         12.66 kN.
          -. Muy    =          0.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.30 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.51

          -. Vuy    =          2.96 kN.
          -. Muz    =          0.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.30 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.51
```

( ). Compute shear strength of concrete.
-. Vuz = 12.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 2036.79 kN.
-. phiVcz = phi * Vcz = 1833.11 kN.

-. Vuy = 2.96 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 2036.79 kN.
-. phiVcy = phi * Vcy = 1833.11 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2410.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5111.70 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2410.52 kN.
-. phiVsz = phi*Vsz = 2169.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2410.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5111.70 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2410.52 kN.
-. phiVsy = phi*Vsy = 2169.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 12.999 kN.
-. Vr = 4002.580 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 14.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 14.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118136,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3126.24        -0.40         0.00        -0.14         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3126.24        -0.40         0.00        -0.14         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.40 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.128  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        560.91 kN.
          -. Vuz    =          1.88 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  29.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   4.52

          -. Vuy    =          1.04 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  29.29 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   4.52
```

( ). Compute shear strength of concrete.
-. Vuz = 1.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 2043.28 kN.
-. phiVcz = phi * Vcz = 1838.95 kN.

-. Vuy = 1.04 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 2043.28 kN.
-. phiVcy = phi * Vcy = 1838.95 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2412.08 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5105.21 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2412.08 kN.
-. phiVsz = phi*Vsz = 2170.87 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2412.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5105.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2412.08 kN.
-. phiVsy = phi*Vsy = 2170.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 2.148 kN.
-. Vr = 4009.823 kN.
-. Ratio = Vu / Vr =5.356e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 2.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 2.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118202,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            160.37      2096.51      1479.21      1808.44      1457.96
           ------------------------------------------------------------------------------
            DL+LL+Others      160.37      2096.51      1479.21      1808.44      1457.96
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1479.21 kN-m.
           -. End Moments (My2) =     2096.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2096.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2096.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1457.96 kN-m.
          -. End Moments (Mz2) =     1808.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1808.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1808.44 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       289.563 kN.
          -. Mry        =      3775.537 kN-m.
          -. Mrz        =      3264.367 kN-m.
          -. Mr         =      4991.069 kN-m.
          -. Pu/Pr      =   0.554  --->  O.K !
          -. Muy/Mry    =   0.555  --->  O.K !
          -. Muz/Mrz    =   0.554  --->  O.K !
          -. Mu/Mr      =   0.555  --->  O.K !
          -. Ratio      =   0.555  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2000.49 kN.
          -. Vuz    =       1259.48 kN.
          -. Muy    =      -2202.86 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.34

          -. Vuy    =        567.71 kN.
          -. Muz    =      -1245.48 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.24
```

( ). Compute shear strength of concrete.
-. Vuz = 1259.48 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1054.95 kN.
-. phiVcz = phi * Vcz = 949.46 kN.

-. Vuy = 567.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1011.66 kN.
-. phiVcy = phi * Vcy = 910.49 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2011.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6093.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2011.24 kN.
-. phiVsz = phi*Vsz = 1810.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1980.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6136.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1980.45 kN.
-. phiVsy = phi*Vsy = 1782.41 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1381.516 kN.
-. Vr = 2692.900 kN.
-. Ratio = Vu / Vr = 0.513 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1535.02 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1535.02 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0074 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0074 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0074 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118203,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            172.27      1479.21       916.04      1457.96      1131.54
           ------------------------------------------------------------------------------
            DL+LL+Others      172.27      1479.21       916.04      1457.96      1131.54
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      916.04 kN-m.
           -. End Moments (My2) =     1479.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1479.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1479.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1131.54 kN-m.
          -. End Moments (Mz2) =     1457.96 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1457.96 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1457.96 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       414.413 kN.
          -. Mry        =      3569.611 kN-m.
          -. Mrz        =      3512.570 kN-m.
          -. Mr         =      5008.021 kN-m.
          -. Pu/Pr      =   0.416  --->  O.K !
          -. Muy/Mry    =   0.414  --->  O.K !
          -. Muz/Mrz    =   0.415  --->  O.K !
          -. Mu/Mr      =   0.416  --->  O.K !
          -. Ratio      =   0.416  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2017.24 kN.
          -. Vuz    =       1156.66 kN.
          -. Muy    =      -1578.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56

          -. Vuy    =        526.78 kN.
          -. Muz    =       -964.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.46
```

( ). Compute shear strength of concrete.
-. Vuz = 1156.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1154.38 kN.
-. phiVcz = phi * Vcz = 1038.95 kN.

-. Vuy = 526.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1111.08 kN.
-. phiVcy = phi * Vcy = 999.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2075.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5994.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2075.24 kN.
-. phiVsz = phi*Vsz = 1867.72 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2048.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6037.40 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2048.44 kN.
-. phiVsy = phi*Vsy = 1843.60 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1270.971 kN.
-. Vr = 2843.570 kN.
-. Ratio = Vu / Vr = 0.447 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1412.19 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1412.19 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0051 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0051 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0051 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118204,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            184.17       916.04       409.62      1131.54       836.05
           ---------------------------------------------------------------------------
            DL+LL+Others      184.17       916.04       409.62      1131.54       836.05
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      409.62 kN-m.
           -. End Moments (My2) =      916.04 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      916.04 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      916.04 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      836.05 kN-m.
          -. End Moments (Mz2) =     1131.54 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1131.54 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1131.54 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       636.240 kN.
          -. Mry        =      3170.713 kN-m.
          -. Mrz        =      3902.861 kN-m.
          -. Mr         =      5028.493 kN-m.
          -. Pu/Pr      =   0.289  --->  O.K !
          -. Muy/Mry    =   0.289  --->  O.K !
          -. Muz/Mrz    =   0.290  --->  O.K !
          -. Mu/Mr      =   0.290  --->  O.K !
          -. Ratio      =   0.290  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2033.98 kN.
          -. Vuz    =       1051.27 kN.
          -. Muy    =      -1007.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.34 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =        484.30 kN.
          -. Muz    =       -704.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.70
```

( ). Compute shear strength of concrete.
-. Vuz = 1051.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1264.50 kN.
-. phiVcz = phi * Vcz = 1138.05 kN.

-. Vuy = 484.30 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1222.05 kN.
-. phiVcy = phi * Vcy = 1099.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2136.95 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5883.98 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2136.95 kN.
-. phiVsz = phi*Vsz = 1923.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2114.18 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5926.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2114.18 kN.
-. phiVsy = phi*Vsy = 1902.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1157.459 kN.
-. Vr = 3002.609 kN.
-. Ratio = Vu / Vr = 0.385 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1286.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1286.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118205,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            196.07       409.62       164.41       836.05       638.17
           ------------------------------------------------------------------------------
            DL+LL+Others      196.07       409.62       164.41       836.05       638.17
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      164.41 kN-m.
           -. End Moments (My2) =      409.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      409.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      409.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      638.17 kN-m.
          -. End Moments (Mz2) =      836.05 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      836.05 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      836.05 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1058.937 kN.
          -. Mry        =      2226.263 kN-m.
          -. Mrz        =      4542.102 kN-m.
          -. Mr         =      5058.353 kN-m.
          -. Pu/Pr      =   0.185  --->  O.K !
          -. Muy/Mry    =   0.184  --->  O.K !
          -. Muz/Mrz    =   0.184  --->  O.K !
          -. Mu/Mr      =   0.185  --->  O.K !
          -. Ratio      =   0.185  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2067.38 kN.
          -. Vuz    =        944.40 kN.
          -. Muy    =       -239.79 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96

          -. Vuy    =        440.72 kN.
          -. Muz    =       -335.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 944.40 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1338.81 kN.
-. phiVcz = phi * Vcz = 1204.93 kN.

-. Vuy = 440.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1297.44 kN.
-. phiVcy = phi * Vcy = 1167.70 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2174.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5809.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2174.07 kN.
-. phiVsz = phi*Vsz = 1956.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2153.81 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5851.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2153.81 kN.
-. phiVsy = phi*Vsy = 1938.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1042.170 kN.
-. Vr = 3106.128 kN.
-. Ratio = Vu / Vr = 0.336 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1157.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1157.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118206,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -322.02       212.10       323.08       489.40       578.04
           ------------------------------------------------------------------------------
           DL+LL+Others     -322.02       212.10       323.08       489.40       578.04
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2132.282 kN.
          -. Mry        =      2148.664 kN-m.
          -. Mrz        =      3823.145 kN-m.
          -. Mr         =      4385.566 kN-m.
          -. Pu/Pr      =   0.151  --->  O.K !
          -. Muy/Mry    =   0.150  --->  O.K !
          -. Muz/Mrz    =   0.151  --->  O.K !
          -. Mu/Mr      =   0.151  --->  O.K !
          -. Ratio      =   0.151  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2084.12 kN.
          -. Vuz    =        837.23 kN.
          -. Muy    =       -613.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.05
```

```
          -. Vuy    =       396.55 kN.
          -. Muz    =      -259.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96

     ( ). Compute shear strength of concrete.
          -. Vuz       =     837.23 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1376.51 kN.
          -. phiVcz    = phi * Vcz =     1238.86 kN.

          -. Vuy       =     396.55 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1335.85 kN.
          -. phiVcy    = phi * Vcy =     1202.26 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2191.68 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5771.98 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2191.68 kN.
          -. phiVsz   = phi*Vsz =     1972.51 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2172.65 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5812.64 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2172.65 kN.
          -. phiVsy   = phi*Vsy =     1955.38 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     926.397 kN.
          -. Vr       =    3157.647 kN.
          -. Ratio    = Vu / Vr = 0.293  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1029.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1029.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118207,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2100.86      -613.42      -945.23      -259.35      -220.50
           ------------------------------------------------------------------------------
            DL+LL+Others     2100.86      -613.42      -945.23      -259.35      -220.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      613.42 kN-m.
           -. End Moments (My2) =      945.23 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -945.23 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -945.23 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      220.50 kN-m.
          -. End Moments (Mz2) =      259.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -220.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -220.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10320.238 kN.
          -. Mry        =      4682.581 kN-m.
          -. Mrz        =      1089.750 kN-m.
          -. Mr         =      4807.714 kN-m.
          -. Pu/Pr      =   0.204  --->  O.K !
          -. Muy/Mry    =   0.202  --->  O.K !
          -. Muz/Mrz    =   0.202  --->  O.K !
          -. Mu/Mr      =   0.204  --->  O.K !
          -. Ratio      =   0.204  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2100.86 kN.
          -. Vuz    =        730.98 kN.
          -. Muy    =       -945.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =        352.28 kN.
          -. Muz    =       -220.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 730.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1360.98 kN.
-. phiVcz = phi * Vcz = 1224.89 kN.

-. Vuy = 352.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1320.02 kN.
-. phiVcy = phi * Vcy = 1188.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2184.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5787.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2184.52 kN.
-. phiVsz = phi*Vsz = 1966.07 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2164.99 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5828.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2164.99 kN.
-. phiVsy = phi*Vsy = 1948.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 811.438 kN.
-. Vr = 3136.508 kN.
-. Ratio = Vu / Vr = 0.259 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 901.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 901.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118208,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2117.60      -945.23     -1230.19      -220.50      -282.88
           ------------------------------------------------------------------------------
            DL+LL+Others     2117.60      -945.23     -1230.19      -220.50      -282.88
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      945.23 kN-m.
           -. End Moments (My2) =     1230.19 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1230.19 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1230.19 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      220.50 kN-m.
          -. End Moments (Mz2) =      282.88 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -282.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -282.88 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8331.034 kN.
          -. Mry        =      4874.632 kN-m.
          -. Mrz        =      1118.398 kN-m.
          -. Mr         =      5001.284 kN-m.
          -. Pu/Pr      =   0.254  --->  O.K !
          -. Muy/Mry    =   0.252  --->  O.K !
          -. Muz/Mrz    =   0.253  --->  O.K !
          -. Mu/Mr      =   0.254  --->  O.K !
          -. Ratio      =   0.254  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2117.60 kN.
          -. Vuz    =        626.88 kN.
          -. Muy    =      -1230.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.99 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.93

          -. Vuy    =        308.46 kN.
          -. Muz    =       -282.88 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 626.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1322.51 kN.
-. phiVcz = phi * Vcz = 1190.26 kN.

-. Vuy = 308.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1280.87 kN.
-. phiVcy = phi * Vcy = 1152.78 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2166.21 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5825.97 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2166.21 kN.
-. phiVsz = phi*Vsz = 1949.59 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2145.42 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5867.62 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2145.42 kN.
-. phiVsy = phi*Vsy = 1930.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 698.658 kN.
-. Vr = 3083.656 kN.
-. Ratio = Vu / Vr = 0.227 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 776.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 776.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118209,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            255.71      1178.21      1423.79       424.70       509.23
           ---------------------------------------------------------------------------
            DL+LL+Others      255.71      1178.21      1423.79       424.70       509.23
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1178.21 kN-m.
           -. End Moments (My2) =     1423.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1423.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1423.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      424.70 kN-m.
          -. End Moments (Mz2) =      509.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      509.23 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      509.23 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       850.665 kN.
          -. Mry        =      4749.548 kN-m.
          -. Mrz        =      1706.038 kN-m.
          -. Mr         =      5046.659 kN-m.
          -. Pu/Pr      =   0.301  --->  O.K !
          -. Muy/Mry    =   0.300  --->  O.K !
          -. Muz/Mrz    =   0.298  --->  O.K !
          -. Mu/Mr      =   0.301  --->  O.K !
          -. Ratio      =   0.301  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2134.33 kN.
          -. Vuz    =        526.21 kN.
          -. Muy    =      -1468.29 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        265.72 kN.
          -. Muz    =       -413.39 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 526.21 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1290.64 kN.
-. phiVcz = phi * Vcz = 1161.58 kN.

-. Vuy = 265.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1248.52 kN.
-. phiVcy = phi * Vcy = 1123.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2150.39 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5857.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2150.39 kN.
-. phiVsz = phi*Vsz = 1935.35 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2128.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5899.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2128.52 kN.
-. phiVsy = phi*Vsy = 1915.67 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 589.493 kN.
-. Vr = 3039.341 kN.
-. Ratio = Vu / Vr = 0.194 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 654.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 654.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118210,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            267.63      1423.79      1623.81       509.23       594.04
           ---------------------------------------------------------------------------
            DL+LL+Others      267.63      1423.79      1623.81       509.23       594.04
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1423.79 kN-m.
           -. End Moments (My2) =     1623.81 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1623.81 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1623.81 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      509.23 kN-m.
          -. End Moments (Mz2) =      594.04 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      594.04 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      594.04 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       774.534 kN.
          -. Mry        =      4730.964 kN-m.
          -. Mrz        =      1738.323 kN-m.
          -. Mr         =      5040.217 kN-m.
          -. Pu/Pr      =   0.346  --->  O.K !
          -. Muy/Mry    =   0.343  --->  O.K !
          -. Muz/Mrz    =   0.342  --->  O.K !
          -. Mu/Mr      =   0.346  --->  O.K !
          -. Ratio      =   0.346  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2151.06 kN.
          -. Vuz    =        430.22 kN.
          -. Muy    =      -1661.08 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80

          -. Vuy    =        224.57 kN.
          -. Muz    =       -540.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.60 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 430.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1266.62 kN.
-. phiVcz = phi * Vcz = 1139.95 kN.

-. Vuy = 224.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1224.19 kN.
-. phiVcy = phi * Vcy = 1101.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2138.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5881.87 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2138.05 kN.
-. phiVsz = phi*Vsz = 1924.25 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2115.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5924.30 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2115.36 kN.
-. phiVsy = phi*Vsy = 1903.82 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 485.310 kN.
-. Vr = 3005.589 kN.
-. Ratio = Vu / Vr = 0.161 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 539.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 539.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118211,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            279.55      1623.81      1781.01       594.04       667.00
           ------------------------------------------------------------------------------
            DL+LL+Others      279.55      1623.81      1781.01       594.04       667.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1623.81 kN-m.
           -. End Moments (My2) =     1781.01 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1781.01 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1781.01 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      594.04 kN-m.
          -. End Moments (Mz2) =      667.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      667.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      667.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       746.364 kN.
          -. Mry        =      4715.064 kN-m.
          -. Mrz        =      1774.286 kN-m.
          -. Mr         =      5037.848 kN-m.
          -. Pu/Pr      =   0.375  --->  O.K !
          -. Muy/Mry    =   0.378  --->  O.K !
          -. Muz/Mrz    =   0.376  --->  O.K !
          -. Mu/Mr      =   0.378  --->  O.K !
          -. Ratio      =   0.378  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        279.55 kN.
          -. Vuz    =        326.28 kN.
          -. Muy    =       1781.01 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =        261.58 kN.
          -. Muz    =        667.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01
```

( ). Compute shear strength of concrete.
-. Vuz = 326.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1360.34 kN.
-. phiVcz = phi * Vcz = 1224.31 kN.

-. Vuy = 261.58 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1360.34 kN.
-. phiVcy = phi * Vcy = 1224.31 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2184.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5788.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2184.22 kN.
-. phiVsz = phi*Vsz = 1965.80 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2184.22 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5788.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2184.22 kN.
-. phiVsy = phi*Vsy = 1965.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 418.184 kN.
-. Vr = 3190.102 kN.
-. Ratio = Vu / Vr = 0.131 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 464.65 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 464.65 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0064 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0064 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0064 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118212,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            291.47      1781.01      1901.59       667.00       727.97
           ---------------------------------------------------------------------------
            DL+LL+Others      291.47      1781.01      1901.59       667.00       727.97
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1781.01 kN-m.
           -. End Moments (My2) =     1901.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1901.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1901.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      667.00 kN-m.
          -. End Moments (Mz2) =      727.97 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      727.97 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      727.97 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       717.692 kN.
          -. Mry        =      4699.478 kN-m.
          -. Mrz        =      1808.499 kN-m.
          -. Mr         =      5035.451 kN-m.
          -. Pu/Pr      =   0.406  --->  O.K !
          -. Muy/Mry    =   0.405  --->  O.K !
          -. Muz/Mrz    =   0.403  --->  O.K !
          -. Mu/Mr      =   0.406  --->  O.K !
          -. Ratio      =   0.406  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        291.47 kN.
          -. Vuz    =        243.93 kN.
          -. Muy    =       1901.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.84 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98

          -. Vuy    =        217.34 kN.
          -. Muz    =        727.97 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.98
```

( ). Compute shear strength of concrete.
-. Vuz = 243.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1347.60 kN.
-. phiVcz = phi * Vcz = 1212.84 kN.

-. Vuy = 217.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1347.60 kN.
-. phiVcy = phi * Vcy = 1212.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2178.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5800.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2178.24 kN.
-. phiVsz = phi*Vsz = 1960.42 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2178.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5800.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2178.24 kN.
-. phiVsy = phi*Vsy = 1960.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 326.709 kN.
-. Vr = 3173.256 kN.
-. Ratio = Vu / Vr = 0.103 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 363.01 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 363.01 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0066 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0066 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0066 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118213,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            303.40      1901.59      1971.07       727.97       769.35
           ------------------------------------------------------------------------------
            DL+LL+Others      303.40      1901.59      1971.07       727.97       769.35
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1901.59 kN-m.
           -. End Moments (My2) =     1971.07 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1971.07 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1971.07 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      727.97 kN-m.
          -. End Moments (Mz2) =      769.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      769.35 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      769.35 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =       717.211 kN.
           -. Mry        =      4685.473 kN-m.
           -. Mrz        =      1828.137 kN-m.
           -. Mr         =      5029.487 kN-m.
           -. Pu/Pr      =   0.423  --->  O.K !
           -. Muy/Mry    =   0.421  --->  O.K !
           -. Muz/Mrz    =   0.421  --->  O.K !
           -. Mu/Mr      =   0.423  --->  O.K !
           -. Ratio      =   0.423  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =        303.40 kN.
           -. Vuz    =        136.60 kN.
           -. Muy    =       1971.07 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.82 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.99

           -. Vuy    =        158.16 kN.
           -. Muz    =        769.35 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.82 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.99
```

( ). Compute shear strength of concrete.
-. Vuz = 136.60 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1351.12 kN.
-. phiVcz = phi * Vcz = 1216.01 kN.

-. Vuy = 158.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1351.12 kN.
-. phiVcy = phi * Vcy = 1216.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2179.90 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5797.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2179.90 kN.
-. phiVsz = phi*Vsz = 1961.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2179.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5797.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2179.90 kN.
-. phiVsy = phi*Vsy = 1961.91 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 208.985 kN.
-. Vr = 3177.921 kN.
-. Ratio = Vu / Vr = 0.066 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 232.21 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 232.21 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0065 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0065 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0065 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118214,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            315.33      1971.07      1978.82       769.35       787.17
           ------------------------------------------------------------------------------
            DL+LL+Others      315.33      1971.07      1978.82       769.35       787.17
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1971.07 kN-m.
           -. End Moments (My2) =     1978.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1978.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1978.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      769.35 kN-m.
          -. End Moments (Mz2) =      787.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      787.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      787.17 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =       746.689 kN.
           -. Mry        =      4675.547 kN-m.
           -. Mrz        =      1860.180 kN-m.
           -. Mr         =      5031.999 kN-m.
           -. Pu/Pr      =   0.422  --->  O.K !
           -. Muy/Mry    =   0.423  --->  O.K !
           -. Muz/Mrz    =   0.423  --->  O.K !
           -. Mu/Mr      =   0.423  --->  O.K !
           -. Ratio      =   0.423  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =        315.33 kN.
           -. Vuz    =         17.14 kN.
           -. Muy    =       1978.82 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.73 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.03

           -. Vuy    =         94.74 kN.
           -. Muz    =        787.17 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.73 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.03
```

( ). Compute shear strength of concrete.
-. Vuz = 17.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1367.79 kN.
-. phiVcz = phi * Vcz = 1231.01 kN.

-. Vuy = 94.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1367.79 kN.
-. phiVcy = phi * Vcy = 1231.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2187.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5780.69 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2187.67 kN.
-. phiVsz = phi*Vsz = 1968.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2187.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5780.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2187.67 kN.
-. phiVsy = phi*Vsy = 1968.91 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 96.277 kN.
-. Vr = 3199.920 kN.
-. Ratio = Vu / Vr = 0.030 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 106.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 106.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0063 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0063 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0063 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118215,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            315.27      1978.82      1934.32       787.17       782.83
           ------------------------------------------------------------------------------
            DL+LL+Others      315.27      1978.82      1934.32       787.17       782.83
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1934.32 kN-m.
           -. End Moments (My2) =     1978.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1978.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1978.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      782.83 kN-m.
          -. End Moments (Mz2) =      787.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      787.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      787.17 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       746.689 kN.
          -. Mry        =      4675.547 kN-m.
          -. Mrz        =      1860.180 kN-m.
          -. Mr         =      5031.999 kN-m.
          -. Pu/Pr      =   0.422  --->  O.K !
          -. Muy/Mry    =   0.423  --->  O.K !
          -. Muz/Mrz    =   0.423  --->  O.K !
          -. Mu/Mr      =   0.423  --->  O.K !
          -. Ratio      =   0.423  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2218.01 kN.
          -. Vuz    =        109.03 kN.
          -. Muy    =      -1991.15 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.76

          -. Vuy    =         33.75 kN.
          -. Muz    =       -856.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.66
```

( ). Compute shear strength of concrete.
-. Vuz = 109.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1245.05 kN.
-. phiVcz = phi * Vcz = 1120.54 kN.

-. Vuy = 33.75 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1202.38 kN.
-. phiVcy = phi * Vcy = 1082.14 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2126.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5903.44 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2126.67 kN.
-. phiVsz = phi*Vsz = 1914.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2103.21 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5946.11 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2103.21 kN.
-. phiVsy = phi*Vsy = 1892.89 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 114.131 kN.
-. Vr = 2975.028 kN.
-. Ratio = Vu / Vr = 0.038 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 126.81 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 126.81 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118216,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            327.20      1934.32      1846.93       782.83       758.61
           ------------------------------------------------------------------------------
            DL+LL+Others      327.20      1934.32      1846.93       782.83       758.61
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1846.93 kN-m.
           -. End Moments (My2) =     1934.32 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1934.32 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1934.32 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      758.61 kN-m.
          -. End Moments (Mz2) =      782.83 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      782.83 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      782.83 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       786.411 kN.
          -. Mry        =      4667.270 kN-m.
          -. Mrz        =      1889.899 kN-m.
          -. Mr         =      5035.388 kN-m.
          -. Pu/Pr      =   0.416  --->  O.K !
          -. Muy/Mry    =   0.414  --->  O.K !
          -. Muz/Mrz    =   0.414  --->  O.K !
          -. Mu/Mr      =   0.416  --->  O.K !
          -. Ratio      =   0.416  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2234.73 kN.
          -. Vuz    =        189.16 kN.
          -. Muy    =      -1942.04 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =         43.97 kN.
          -. Muz    =       -867.67 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 189.16 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1239.15 kN.
-. phiVcz = phi * Vcz = 1115.23 kN.

-. Vuy = 43.97 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1196.42 kN.
-. phiVcy = phi * Vcy = 1076.78 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2123.50 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5909.34 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2123.50 kN.
-. phiVsz = phi*Vsz = 1911.15 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2099.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5952.07 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2099.83 kN.
-. phiVsy = phi*Vsy = 1889.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 194.201 kN.
-. Vr = 2966.624 kN.
-. Ratio = Vu / Vr = 0.065 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 215.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 215.78 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118217,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            339.14      1846.93      1726.54       758.61       718.44
           ------------------------------------------------------------------------------
            DL+LL+Others      339.14      1846.93      1726.54       758.61       718.44
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1726.54 kN-m.
           -. End Moments (My2) =     1846.93 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1846.93 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1846.93 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      718.44 kN-m.
          -. End Moments (Mz2) =      758.61 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      758.61 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      758.61 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       861.366 kN.
          -. Mry        =      4663.179 kN-m.
          -. Mrz        =      1916.780 kN-m.
          -. Mr         =      5041.754 kN-m.
          -. Pu/Pr      =   0.394  --->  O.K !
          -. Muy/Mry    =   0.396  --->  O.K !
          -. Muz/Mrz    =   0.396  --->  O.K !
          -. Mu/Mr      =   0.396  --->  O.K !
          -. Ratio      =   0.396  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2251.44 kN.
          -. Vuz    =        250.75 kN.
          -. Muy    =      -1850.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =         77.26 kN.
          -. Muz    =       -853.78 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.66
```

( ). Compute shear strength of concrete.
-. Vuz = 250.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1242.86 kN.
-. phiVcz = phi * Vcz = 1118.57 kN.

-. Vuy = 77.26 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1200.17 kN.
-. phiVcy = phi * Vcy = 1080.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2125.50 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5905.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2125.50 kN.
-. phiVsz = phi*Vsz = 1912.95 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2101.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5948.32 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2101.96 kN.
-. phiVsy = phi*Vsy = 1891.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 262.382 kN.
-. Vr = 2971.914 kN.
-. Ratio = Vu / Vr = 0.088 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 291.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 291.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118218,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                           -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            351.08      1726.54      1582.73       718.44       666.41
           ---------------------------------------------------------------------------
            DL+LL+Others      351.08      1726.54      1582.73       718.44       666.41
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1582.73 kN-m.
           -. End Moments (My2) =     1726.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1726.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1726.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      666.41 kN-m.
          -. End Moments (Mz2) =      718.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      718.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      718.44 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       947.984 kN.
          -. Mry        =      4661.070 kN-m.
          -. Mrz        =      1941.017 kN-m.
          -. Mr         =      5049.072 kN-m.
          -. Pu/Pr      =   0.370  --->  O.K !
          -. Muy/Mry    =   0.370  --->  O.K !
          -. Muz/Mrz    =   0.370  --->  O.K !
          -. Mu/Mr      =   0.370  --->  O.K !
          -. Ratio      =   0.370  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2268.14 kN.
          -. Vuz    =        294.03 kN.
          -. Muy    =      -1727.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        105.22 kN.
          -. Muz    =       -819.09 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.68 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.68
```

( ). Compute shear strength of concrete.
-. Vuz = 294.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1255.49 kN.
-. phiVcz = phi * Vcz = 1129.94 kN.

-. Vuy = 105.22 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1212.93 kN.
-. phiVcy = phi * Vcy = 1091.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2132.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5893.00 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2132.22 kN.
-. phiVsz = phi*Vsz = 1919.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2109.13 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5935.56 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2109.13 kN.
-. phiVsy = phi*Vsy = 1898.22 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 312.290 kN.
-. Vr = 2989.852 kN.
-. Ratio = Vu / Vr = 0.104 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 346.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 346.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118219,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2284.85     -1580.93     -1420.87      -768.40      -706.36
           ------------------------------------------------------------------------------
            DL+LL+Others     2284.85     -1580.93     -1420.87      -768.40      -706.36
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1420.87 kN-m.
           -. End Moments (My2) =     1580.93 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1580.93 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1580.93 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      706.36 kN-m.
          -. End Moments (Mz2) =      768.40 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -768.40 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -768.40 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      6759.736 kN.
          -. Mry        =      4638.328 kN-m.
          -. Mrz        =      2263.540 kN-m.
          -. Mr         =      5161.173 kN-m.
          -. Pu/Pr      =   0.338  --->  O.K !
          -. Muy/Mry    =   0.341  --->  O.K !
          -. Muz/Mrz    =   0.339  --->  O.K !
          -. Mu/Mr      =   0.341  --->  O.K !
          -. Ratio      =   0.341  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2284.85 kN.
          -. Vuz    =        320.64 kN.
          -. Muy    =      -1580.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.27 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.82

          -. Vuy    =        125.69 kN.
          -. Muz    =       -768.40 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.73
```

( ). Compute shear strength of concrete.
-. Vuz = 320.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1275.68 kN.
-. phiVcz = phi * Vcz = 1148.11 kN.

-. Vuy = 125.69 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1233.36 kN.
-. phiVcy = phi * Vcy = 1110.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2142.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5872.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2142.75 kN.
-. phiVsz = phi*Vsz = 1928.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2120.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5915.12 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2120.37 kN.
-. phiVsy = phi*Vsy = 1908.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 344.400 kN.
-. Vr = 3018.360 kN.
-. Ratio = Vu / Vr = 0.114 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 382.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 382.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0025 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118220,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2301.55     -1420.87     -1255.29      -706.36      -637.29
           ------------------------------------------------------------------------------
            DL+LL+Others     2301.55     -1420.87     -1255.29      -706.36      -637.29
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1255.29 kN-m.
           -. End Moments (My2) =     1420.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1420.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1420.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      637.29 kN-m.
          -. End Moments (Mz2) =      706.36 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -706.36 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -706.36 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7421.418 kN.
          -. Mry        =      4570.436 kN-m.
          -. Mrz        =      2280.317 kN-m.
          -. Mr         =      5107.713 kN-m.
          -. Pu/Pr      =   0.310  --->  O.K !
          -. Muy/Mry    =   0.311  --->  O.K !
          -. Muz/Mrz    =   0.310  --->  O.K !
          -. Mu/Mr      =   0.311  --->  O.K !
          -. Ratio      =   0.311  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2301.55 kN.
          -. Vuz    =        331.51 kN.
          -. Muy    =      -1420.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        138.50 kN.
          -. Muz    =       -706.36 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.36 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.79
```

( ). Compute shear strength of concrete.
-. Vuz = 331.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1302.28 kN.
-. phiVcz = phi * Vcz = 1172.06 kN.

-. Vuy = 138.50 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1260.33 kN.
-. phiVcy = phi * Vcy = 1134.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2156.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5846.20 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2156.24 kN.
-. phiVsz = phi*Vsz = 1940.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2134.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5888.16 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2134.77 kN.
-. phiVsy = phi*Vsy = 1921.29 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 359.278 kN.
-. Vr = 3055.585 kN.
-. Ratio = Vu / Vr = 0.118 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 399.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 399.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118221,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2318.25     -1255.29     -1091.53      -637.29      -565.12
           ------------------------------------------------------------------------------
            DL+LL+Others     2318.25     -1255.29     -1091.53      -637.29      -565.12
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1091.53 kN-m.
           -. End Moments (My2) =     1255.29 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1255.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1255.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      565.12 kN-m.
          -. End Moments (Mz2) =      637.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -637.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -637.29 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8267.977 kN.
          -. Mry        =      4468.922 kN-m.
          -. Mrz        =      2265.063 kN-m.
          -. Mr         =      5010.167 kN-m.
          -. Pu/Pr      =   0.280  --->  O.K !
          -. Muy/Mry    =   0.281  --->  O.K !
          -. Muz/Mrz    =   0.281  --->  O.K !
          -. Mu/Mr      =   0.281  --->  O.K !
          -. Ratio      =   0.281  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2318.25 kN.
          -. Vuz    =        328.00 kN.
          -. Muy    =      -1255.29 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.92 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        144.49 kN.
          -. Muz    =       -637.29 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86
```

( ). Compute shear strength of concrete.
-. Vuz = 328.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1334.08 kN.
-. phiVcz = phi * Vcz = 1200.67 kN.

-. Vuy = 144.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1292.63 kN.
-. phiVcy = phi * Vcy = 1163.36 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2171.80 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5814.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2171.80 kN.
-. phiVsz = phi*Vsz = 1954.62 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2151.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5855.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2151.39 kN.
-. phiVsy = phi*Vsy = 1936.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 358.414 kN.
-. Vr = 3099.615 kN.
-. Ratio = Vu / Vr = 0.116 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 398.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 398.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118222,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2334.95     -1091.53      -935.67      -565.12      -493.33
           ------------------------------------------------------------------------------
            DL+LL+Others     2334.95     -1091.53      -935.67      -565.12      -493.33
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      935.67 kN-m.
           -. End Moments (My2) =     1091.53 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1091.53 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1091.53 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      493.33 kN-m.
          -. End Moments (Mz2) =      565.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -565.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -565.12 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9261.491 kN.
          -. Mry        =      4348.209 kN-m.
          -. Mrz        =      2248.161 kN-m.
          -. Mr         =      4895.012 kN-m.
          -. Pu/Pr      =   0.252  --->  O.K !
          -. Muy/Mry    =   0.251  --->  O.K !
          -. Muz/Mrz    =   0.251  --->  O.K !
          -. Mu/Mr      =   0.252  --->  O.K !
          -. Ratio      =   0.252  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2334.95 kN.
          -. Vuz    =        312.05 kN.
          -. Muy    =      -1091.53 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.03

          -. Vuy    =        143.67 kN.
          -. Muz    =       -565.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.95 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.94
```

( ). Compute shear strength of concrete.
-. Vuz = 312.05 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1369.81 kN.
-. phiVcz = phi * Vcz = 1232.83 kN.

-. Vuy = 143.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1329.01 kN.
-. phiVcy = phi * Vcy = 1196.11 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2188.60 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5778.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2188.60 kN.
-. phiVsz = phi*Vsz = 1969.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2169.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5819.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2169.36 kN.
-. phiVsy = phi*Vsy = 1952.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 343.534 kN.
-. Vr = 3148.534 kN.
-. Ratio = Vu / Vr = 0.109 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 381.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 381.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118223,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2351.64      -935.67      -792.24      -493.33      -424.74
           ------------------------------------------------------------------------------
            DL+LL+Others     2351.64      -935.67      -792.24      -493.33      -424.74
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      792.24 kN-m.
           -. End Moments (My2) =      935.67 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -935.67 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -935.67 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      424.74 kN-m.
          -. End Moments (Mz2) =      493.33 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -493.33 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -493.33 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10559.230 kN.
          -. Mry        =      4235.113 kN-m.
          -. Mrz        =      2230.924 kN-m.
          -. Mr         =      4786.774 kN-m.
          -. Pu/Pr      =   0.223  --->  O.K !
          -. Muy/Mry    =   0.221  --->  O.K !
          -. Muz/Mrz    =   0.221  --->  O.K !
          -. Mu/Mr      =   0.223  --->  O.K !
          -. Ratio      =   0.223  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2351.64 kN.
          -. Vuz    =        287.06 kN.
          -. Muy    =       -935.67 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.12

          -. Vuy    =        137.26 kN.
          -. Muz    =       -493.33 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.73 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.03
```

( ). Compute shear strength of concrete.
-. Vuz = 287.06 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1407.87 kN.
-. phiVcz = phi * Vcz = 1267.09 kN.

-. Vuy = 137.26 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1367.89 kN.
-. phiVcy = phi * Vcy = 1231.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2205.76 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5740.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2205.76 kN.
-. phiVsz = phi*Vsz = 1985.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2187.72 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5780.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2187.72 kN.
-. phiVsy = phi*Vsy = 1968.95 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 318.189 kN.
-. Vr = 3200.048 kN.
-. Ratio = Vu / Vr = 0.099 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 353.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 353.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118224,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2368.34      -792.24      -660.35      -424.74      -360.04
           ------------------------------------------------------------------------------
            DL+LL+Others     2368.34      -792.24      -660.35      -424.74      -360.04
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      660.35 kN-m.
           -. End Moments (My2) =      792.24 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -792.24 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -792.24 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      360.04 kN-m.
          -. End Moments (Mz2) =      424.74 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -424.74 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -424.74 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12174.970 kN.
          -. Mry        =      4074.639 kN-m.
          -. Mrz        =      2183.747 kN-m.
          -. Mr         =      4622.925 kN-m.
          -. Pu/Pr      =   0.195  --->  O.K !
          -. Muy/Mry    =   0.194  --->  O.K !
          -. Muz/Mrz    =   0.194  --->  O.K !
          -. Mu/Mr      =   0.195  --->  O.K !
          -. Ratio      =   0.195  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2368.34 kN.
          -. Vuz    =        263.90 kN.
          -. Muy    =       -792.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.34 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.20

          -. Vuy    =        129.45 kN.
          -. Muz    =       -424.74 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.53 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.11
```

( ). Compute shear strength of concrete.
-. Vuz = 263.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1445.13 kN.
-. phiVcz = phi * Vcz = 1300.61 kN.

-. Vuy = 129.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1406.04 kN.
-. phiVcy = phi * Vcy = 1265.44 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2221.85 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5703.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2221.85 kN.
-. phiVsz = phi*Vsz = 1999.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2204.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5742.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2204.95 kN.
-. phiVsy = phi*Vsy = 1984.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 293.936 kN.
-. Vr = 3249.893 kN.
-. Ratio = Vu / Vr = 0.090 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 326.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 326.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118225,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2385.02      -660.35      -541.67      -360.04      -300.38
           ---------------------------------------------------------------------------
            DL+LL+Others     2385.02      -660.35      -541.67      -360.04      -300.38
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      541.67 kN-m.
           -. End Moments (My2) =      660.35 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -660.35 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -660.35 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      300.38 kN-m.
          -. End Moments (Mz2) =      360.04 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -360.04 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -360.04 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     13921.428 kN.
          -. Mry        =      3885.963 kN-m.
          -. Mrz        =      2118.288 kN-m.
          -. Mr         =      4425.817 kN-m.
          -. Pu/Pr      =   0.171  --->  O.K !
          -. Muy/Mry    =   0.170  --->  O.K !
          -. Muz/Mrz    =   0.170  --->  O.K !
          -. Mu/Mr      =   0.171  --->  O.K !
          -. Ratio      =   0.171  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2385.02 kN.
          -. Vuz    =        237.42 kN.
          -. Muy    =       -660.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.16 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.28

          -. Vuy    =        119.35 kN.
          -. Muz    =       -360.04 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.20
```

( ). Compute shear strength of concrete.
-. Vuz = 237.42 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1482.39 kN.
-. phiVcz = phi * Vcz = 1334.15 kN.

-. Vuy = 119.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1444.30 kN.
-. phiVcy = phi * Vcy = 1299.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2237.30 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5666.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2237.30 kN.
-. phiVsz = phi*Vsz = 2013.57 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2221.50 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5704.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2221.50 kN.
-. phiVsy = phi*Vsy = 1999.35 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 265.729 kN.
-. Vr = 3299.227 kN.
-. Ratio = Vu / Vr = 0.081 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 295.25 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 295.25 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118226,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2401.71      -541.67      -437.15      -300.38      -246.54
           ------------------------------------------------------------------------------
            DL+LL+Others     2401.71      -541.67      -437.15      -300.38      -246.54
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      437.15 kN-m.
           -. End Moments (My2) =      541.67 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -541.67 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -541.67 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      246.54 kN-m.
          -. End Moments (Mz2) =      300.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -300.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -300.38 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     16049.507 kN.
          -. Mry        =      3625.259 kN-m.
          -. Mrz        =      1998.063 kN-m.
          -. Mr         =      4139.416 kN-m.
          -. Pu/Pr      =   0.150  --->  O.K !
          -. Muy/Mry    =   0.149  --->  O.K !
          -. Muz/Mrz    =   0.150  --->  O.K !
          -. Mu/Mr      =   0.150  --->  O.K !
          -. Ratio      =   0.150  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2401.71 kN.
          -. Vuz    =        209.09 kN.
          -. Muy    =       -541.67 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.00 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.36

          -. Vuy    =        107.71 kN.
          -. Muz    =       -300.38 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.28
```

( ). Compute shear strength of concrete.
-. Vuz = 209.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1518.67 kN.
-. phiVcz = phi * Vcz = 1366.80 kN.

-. Vuy = 107.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1481.66 kN.
-. phiVcy = phi * Vcy = 1333.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2251.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5629.82 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2251.75 kN.
-. phiVsz = phi*Vsz = 2026.57 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2237.00 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5666.82 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2237.00 kN.
-. phiVsy = phi*Vsy = 2013.30 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 235.204 kN.
-. Vr = 3346.800 kN.
-. Ratio = Vu / Vr = 0.070 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 261.34 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 261.34 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118227,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2418.39      -437.15      -346.26      -246.54      -198.57
           ---------------------------------------------------------------------------
            DL+LL+Others     2418.39      -437.15      -346.26      -246.54      -198.57
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      346.26 kN-m.
           -. End Moments (My2) =      437.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -437.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -437.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      198.57 kN-m.
          -. End Moments (Mz2) =      246.54 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -246.54 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -246.54 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     18142.982 kN.
          -. Mry        =      3302.013 kN-m.
          -. Mrz        =      1862.461 kN-m.
          -. Mr         =      3791.049 kN-m.
          -. Pu/Pr      =   0.133  --->  O.K !
          -. Muy/Mry    =   0.132  --->  O.K !
          -. Muz/Mrz    =   0.132  --->  O.K !
          -. Mu/Mr      =   0.133  --->  O.K !
          -. Ratio      =   0.133  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2418.39 kN.
          -. Vuz    =        181.82 kN.
          -. Muy    =       -437.15 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.44

          -. Vuy    =         95.95 kN.
          -. Muz    =       -246.54 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.36
```

( ). Compute shear strength of concrete.
-. Vuz = 181.82 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1552.66 kN.
-. phiVcz = phi * Vcz = 1397.39 kN.

-. Vuy = 95.95 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1516.76 kN.
-. phiVcy = phi * Vcy = 1365.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2264.79 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5595.83 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2264.79 kN.
-. phiVsz = phi*Vsz = 2038.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2251.00 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5631.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2251.00 kN.
-. phiVsy = phi*Vsy = 2025.90 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 205.583 kN.
-. Vr = 3390.989 kN.
-. Ratio = Vu / Vr = 0.061 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 228.43 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 228.43 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118228,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2978.42      -149.05      -113.98      -228.44      -175.90
           ------------------------------------------------------------------------------
            DL+LL+Others     2978.42      -149.05      -113.98      -228.44      -175.90
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      113.98 kN-m.
           -. End Moments (My2) =      149.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -149.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -149.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      175.90 kN-m.
          -. End Moments (Mz2) =      228.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -228.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -228.44 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24240.127 kN.
          -. Mry        =      1220.456 kN-m.
          -. Mrz        =      1869.270 kN-m.
          -. Mr         =      2232.416 kN-m.
          -. Pu/Pr      =   0.123  --->  O.K !
          -. Muy/Mry    =   0.122  --->  O.K !
          -. Muz/Mrz    =   0.122  --->  O.K !
          -. Mu/Mr      =   0.123  --->  O.K !
          -. Ratio      =   0.123  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2435.07 kN.
          -. Vuz    =        163.67 kN.
          -. Muy    =       -346.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.73 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.50

          -. Vuy    =         87.83 kN.
          -. Muz    =       -198.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.87 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.42
```

( ). Compute shear strength of concrete.
-. Vuz = 163.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1582.02 kN.
-. phiVcz = phi * Vcz = 1423.81 kN.

-. Vuy = 87.83 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1547.14 kN.
-. phiVcy = phi * Vcy = 1392.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2275.69 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5566.47 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2275.69 kN.
-. phiVsz = phi*Vsz = 2048.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2262.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5601.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2262.71 kN.
-. phiVsy = phi*Vsy = 2036.44 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 185.750 kN.
-. Vr = 3428.866 kN.
-. Ratio = Vu / Vr = 0.054 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 206.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 206.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118229,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3011.78      -113.98       -82.54      -175.90      -128.51
           ------------------------------------------------------------------------------
            DL+LL+Others     3011.78      -113.98       -82.54      -175.90      -128.51
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       82.54 kN-m.
           -. End Moments (My2) =      113.98 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -82.54 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -82.54 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      128.51 kN-m.
          -. End Moments (Mz2) =      175.90 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -128.51 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -128.51 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       668.803 kN-m.
          -. Mrz        =      1041.361 kN-m.
          -. Mr         =      1237.631 kN-m.
          -. Pu/Pr      =   0.123  --->  O.K !
          -. Muy/Mry    =   0.123  --->  O.K !
          -. Muz/Mrz    =   0.123  --->  O.K !
          -. Mu/Mr      =   0.123  --->  O.K !
          -. Ratio      =   0.123  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2451.75 kN.
          -. Vuz    =        146.64 kN.
          -. Muy    =       -264.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.56

          -. Vuy    =         79.97 kN.
          -. Muz    =       -154.67 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.49
```

( ). Compute shear strength of concrete.
-. Vuz = 146.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1609.51 kN.
-. phiVcz = phi * Vcz = 1448.56 kN.

-. Vuy = 79.97 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1575.66 kN.
-. phiVcy = phi * Vcy = 1418.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2285.60 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5538.98 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2285.60 kN.
-. phiVsz = phi*Vsz = 2057.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2273.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5572.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2273.36 kN.
-. phiVsy = phi*Vsy = 2046.02 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 167.029 kN.
-. Vr = 3464.115 kN.
-. Ratio = Vu / Vr = 0.048 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 185.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 185.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118230,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3028.48       -82.54       -54.44      -128.51       -85.86
           ------------------------------------------------------------------------------
            DL+LL+Others     3028.48       -82.54       -54.44      -128.51       -85.86
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       54.44 kN-m.
           -. End Moments (My2) =       82.54 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -54.44 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -54.44 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       85.86 kN-m.
          -. End Moments (Mz2) =      128.51 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -85.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -85.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       438.707 kN-m.
          -. Mrz        =       691.889 kN-m.
          -. Mr         =       819.253 kN-m.
          -. Pu/Pr      =   0.124  --->  O.K !
          -. Muy/Mry    =   0.124  --->  O.K !
          -. Muz/Mrz    =   0.124  --->  O.K !
          -. Mu/Mr      =   0.124  --->  O.K !
          -. Ratio      =   0.124  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2468.43 kN.
          -. Vuz    =        131.14 kN.
          -. Muy    =       -191.13 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.62

          -. Vuy    =         72.62 kN.
          -. Muz    =       -114.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.65 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.55
```

( ). Compute shear strength of concrete.
-. Vuz = 131.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1634.92 kN.
-. phiVcz = phi * Vcz = 1471.43 kN.

-. Vuy = 72.62 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1602.07 kN.
-. phiVcy = phi * Vcy = 1441.86 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2294.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5513.56 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2294.52 kN.
-. phiVsz = phi*Vsz = 2065.07 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2282.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5546.42 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2282.95 kN.
-. phiVsy = phi*Vsy = 2054.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 149.904 kN.
-. Vr = 3496.515 kN.
-. Ratio = Vu / Vr = 0.043 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 166.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 166.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118231,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3045.17       -54.44       -32.03       -85.86       -51.46
           ------------------------------------------------------------------------------
            DL+LL+Others     3045.17       -54.44       -32.03       -85.86       -51.46
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       32.03 kN-m.
           -. End Moments (My2) =       54.44 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -32.03 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -32.03 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       51.46 kN-m.
          -. End Moments (Mz2) =       85.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -51.46 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -51.46 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       256.773 kN-m.
          -. Mrz        =       412.383 kN-m.
          -. Mr         =       485.790 kN-m.
          -. Pu/Pr      =   0.125  --->  O.K !
          -. Muy/Mry    =   0.125  --->  O.K !
          -. Muz/Mrz    =   0.125  --->  O.K !
          -. Mu/Mr      =   0.125  --->  O.K !
          -. Ratio      =   0.125  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2485.10 kN.
          -. Vuz    =        104.51 kN.
          -. Muy    =       -125.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.42 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.68

          -. Vuy    =         59.61 kN.
          -. Muz    =        -78.39 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 104.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1661.79 kN.
-. phiVcz = phi * Vcz = 1495.61 kN.

-. Vuy = 59.61 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1630.05 kN.
-. phiVcy = phi * Vcy = 1467.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2303.71 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5486.69 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2303.71 kN.
-. phiVsz = phi*Vsz = 2073.34 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2292.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5518.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2292.83 kN.
-. phiVsy = phi*Vsy = 2063.55 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 120.314 kN.
-. Vr = 3530.590 kN.
-. Ratio = Vu / Vr = 0.034 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 133.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 133.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118232,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3061.86       -32.03       -16.79       -51.46       -27.61
           ------------------------------------------------------------------------------
            DL+LL+Others     3061.86       -32.03       -16.79       -51.46       -27.61
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       16.79 kN-m.
           -. End Moments (My2) =       32.03 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -16.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -16.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       27.61 kN-m.
          -. End Moments (Mz2) =       51.46 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -27.61 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -27.61 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       133.857 kN-m.
          -. Mrz        =       220.016 kN-m.
          -. Mr         =       257.536 kN-m.
          -. Pu/Pr      =   0.125  --->  O.K !
          -. Muy/Mry    =   0.125  --->  O.K !
          -. Muz/Mrz    =   0.125  --->  O.K !
          -. Mu/Mr      =   0.125  --->  O.K !
          -. Ratio      =   0.125  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2501.77 kN.
          -. Vuz    =         70.94 kN.
          -. Muy    =        -73.36 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.73

          -. Vuy    =         42.66 kN.
          -. Muz    =        -48.60 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.67
```

( ). Compute shear strength of concrete.
-. Vuz = 70.94 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1687.16 kN.
-. phiVcz = phi * Vcz = 1518.44 kN.

-. Vuy = 42.66 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1656.51 kN.
-. phiVcy = phi * Vcy = 1490.86 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2312.16 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5461.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2312.16 kN.
-. phiVsz = phi*Vsz = 2080.95 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2301.92 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5491.97 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2301.92 kN.
-. phiVsy = phi*Vsy = 2071.73 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 82.777 kN.
-. Vr = 3562.595 kN.
-. Ratio = Vu / Vr = 0.023 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 91.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 91.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118233,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3078.54       -16.79        -7.34       -27.61       -12.44
           ------------------------------------------------------------------------------
            DL+LL+Others     3078.54       -16.79        -7.34       -27.61       -12.44
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.34 kN-m.
           -. End Moments (My2) =       16.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.34 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.34 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       12.44 kN-m.
          -. End Moments (Mz2) =       27.61 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -12.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -12.44 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        58.211 kN-m.
          -. Mrz        =        98.593 kN-m.
          -. Mr         =       114.495 kN-m.
          -. Pu/Pr      =   0.126  --->  O.K !
          -. Muy/Mry    =   0.126  --->  O.K !
          -. Muz/Mrz    =   0.126  --->  O.K !
          -. Mu/Mr      =   0.126  --->  O.K !
          -. Ratio      =   0.126  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2535.09 kN.
          -. Vuz    =         43.68 kN.
          -. Muy    =        -16.09 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.27 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.77

          -. Vuy    =         28.33 kN.
          -. Muz    =        -13.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.71
```

( ). Compute shear strength of concrete.
-. Vuz = 43.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1703.98 kN.
-. phiVcz = phi * Vcz = 1533.58 kN.

-. Vuy = 28.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1674.09 kN.
-. phiVcy = phi * Vcy = 1506.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2317.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5444.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2317.66 kN.
-. phiVsz = phi*Vsz = 2085.89 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2307.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5474.40 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2307.84 kN.
-. phiVsy = phi*Vsy = 2077.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 52.066 kN.
-. Vr = 3583.733 kN.
-. Ratio = Vu / Vr = 0.015 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 57.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 57.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118234,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3095.21        -7.34        -2.31       -12.44        -4.06
           ------------------------------------------------------------------------------
            DL+LL+Others     3095.21        -7.34        -2.31       -12.44        -4.06
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.31 kN-m.
           -. End Moments (My2) =        7.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.06 kN-m.
          -. End Moments (Mz2) =       12.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.06 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.06 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        18.198 kN-m.
          -. Mrz        =        31.993 kN-m.
          -. Mr         =        36.807 kN-m.
          -. Pu/Pr      =   0.127  --->  O.K !
          -. Muy/Mry    =   0.127  --->  O.K !
          -. Muz/Mrz    =   0.127  --->  O.K !
          -. Mu/Mr      =   0.127  --->  O.K !
          -. Ratio      =   0.127  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2551.75 kN.
          -. Vuz    =         22.89 kN.
          -. Muy    =         -4.66 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.79

          -. Vuy    =         16.72 kN.
          -. Muz    =         -4.78 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.73
```

( ). Compute shear strength of concrete.
-. Vuz = 22.89 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1714.45 kN.
-. phiVcz = phi * Vcz = 1543.01 kN.

-. Vuy = 16.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1685.05 kN.
-. phiVcy = phi * Vcy = 1516.54 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2321.03 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5434.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2321.03 kN.
-. phiVsz = phi*Vsz = 2088.93 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2311.47 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5463.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2311.47 kN.
-. phiVsy = phi*Vsy = 2080.32 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 28.343 kN.
-. Vr = 3596.864 kN.
-. Ratio = Vu / Vr = 0.008 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 31.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 31.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118235,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3111.88        -2.31        -0.31        -4.06        -0.57
           ------------------------------------------------------------------------------
            DL+LL+Others     3111.88        -2.31        -0.31        -4.06        -0.57
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.31 kN-m.
           -. End Moments (My2) =        2.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.57 kN-m.
          -. End Moments (Mz2) =        4.06 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.57 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.57 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         2.415 kN-m.
          -. Mrz        =         4.487 kN-m.
          -. Mr         =         5.096 kN-m.
          -. Pu/Pr      =   0.128  --->  O.K !
          -. Muy/Mry    =   0.128  --->  O.K !
          -. Muz/Mrz    =   0.127  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2568.42 kN.
          -. Vuz    =          8.59 kN.
          -. Muy    =         -0.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.81

          -. Vuy    =          7.85 kN.
          -. Muz    =         -0.87 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.75
```

( ). Compute shear strength of concrete.
-. Vuz = 8.59 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1721.24 kN.
-. phiVcz = phi * Vcz = 1549.11 kN.

-. Vuy = 7.85 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1692.15 kN.
-. phiVcy = phi * Vcy = 1522.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2323.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5427.25 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2323.20 kN.
-. phiVsz = phi*Vsz = 2090.88 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2313.80 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5456.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2313.80 kN.
-. phiVsy = phi*Vsy = 2082.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 11.635 kN.
-. Vr = 3605.357 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 12.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 12.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =118236,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3128.54        -0.31         0.00        -0.57         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3128.54        -0.31         0.00        -0.57         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.57 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.128  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2585.07 kN.
          -. Vuz    =          0.76 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.30 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.75

          -. Vuy    =          1.74 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.30 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.75
```

( ). Compute shear strength of concrete.
-. Vuz = 0.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1695.32 kN.
-. phiVcz = phi * Vcz = 1525.79 kN.

-. Vuy = 1.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1695.32 kN.
-. phiVcy = phi * Vcy = 1525.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2314.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5453.16 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2314.84 kN.
-. phiVsz = phi*Vsz = 2083.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2314.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5453.16 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2314.84 kN.
-. phiVsy = phi*Vsy = 2083.36 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1.899 kN.
-. Vr = 3609.148 kN.
-. Ratio = Vu / Vr =5.260e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 2.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 2.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129002,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1710.66       699.78       626.77      1598.70      1326.00
           ---------------------------------------------------------------------------
           DL+LL+Others    -1710.66       699.78       626.77      1598.70      1326.00
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2313.458 kN.
          -. Mry        =       929.631 kN-m.
          -. Mrz        =      2144.886 kN-m.
          -. Mr         =      2337.680 kN-m.
          -. Pu/Pr      =   0.739  --->  O.K !
          -. Muy/Mry    =   0.753  --->  O.K !
          -. Muz/Mrz    =   0.745  --->  O.K !
          -. Mu/Mr      =   0.753  --->  O.K !
          -. Ratio      =   0.753  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2890.65 kN.
          -. Vuz    =        359.65 kN.
          -. Muy    =       -663.70 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  35.12 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.08
```

```
          -. Vuy    =       569.18 kN.
          -. Muz    =     -1635.19 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  35.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   1.94

     ( ). Compute shear strength of concrete.
          -. Vuz       =     359.65 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     651.36 kN.
          -. phiVcz    = phi * Vcz =     586.22 kN.

          -. Vuy       =     569.18 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     608.22 kN.
          -. phiVcy    = phi * Vcy =     547.40 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      546.38 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4312.87 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      546.38 kN.
          -. phiVsz   = phi*Vsz =      491.74 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      531.16 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4356.01 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      531.16 kN.
          -. phiVsy   = phi*Vsy =      478.04 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     673.284 kN.
          -. Vr       =    1025.439 kN.
          -. Ratio    = Vu / Vr = 0.657  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 531.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 546.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0036 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129003,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1702.75       626.77       562.42      1326.00      1069.63
           ---------------------------------------------------------------------------
           DL+LL+Others    -1702.75       626.77       562.42      1326.00      1069.63
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2633.233 kN.
          -. Mry        =       964.871 kN-m.
          -. Mrz        =      2046.992 kN-m.
          -. Mr         =      2262.996 kN-m.
          -. Pu/Pr      =   0.647  --->  O.K !
          -. Muy/Mry    =   0.650  --->  O.K !
          -. Muz/Mrz    =   0.648  --->  O.K !
          -. Mu/Mr      =   0.650  --->  O.K !
          -. Ratio      =   0.650  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2902.64 kN.
          -. Vuz    =        322.29 kN.
          -. Muy    =       -600.97 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  34.54 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.19
```

```
          -. Vuy    =       535.22 kN.
          -. Muz    =     -1355.07 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  35.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.06

     ( ). Compute shear strength of concrete.
          -. Vuz       =     322.29 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     688.53 kN.
          -. phiVcz    = phi * Vcz =     619.68 kN.

          -. Vuy       =     535.22 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     644.78 kN.
          -. phiVcy    = phi * Vcy =     580.31 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      558.36 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4275.69 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      558.36 kN.
          -. phiVsz   = phi*Vsz =      502.52 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      544.16 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4319.44 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      544.16 kN.
          -. phiVsy   = phi*Vsy =      489.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     624.770 kN.
          -. Vr       =    1070.047 kN.
          -. Ratio    = Vu / Vr = 0.584  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 544.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 558.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0023 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129004,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1694.83       562.42       507.68      1069.63       830.72
           ------------------------------------------------------------------------------
            DL+LL+Others    -1694.83       562.42       507.68      1069.63       830.72
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3047.573 kN.
          -. Mry        =      1016.045 kN-m.
          -. Mrz        =      1913.377 kN-m.
          -. Mr         =      2166.416 kN-m.
          -. Pu/Pr      =   0.556  --->  O.K !
          -. Muy/Mry    =   0.554  --->  O.K !
          -. Muz/Mrz    =   0.559  --->  O.K !
          -. Mu/Mr      =   0.559  --->  O.K !
          -. Ratio      =   0.559  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2914.61 kN.
          -. Vuz    =        284.77 kN.
          -. Muy    =       -545.91 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.99 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.32
```

-. Vuy = 499.18 kN.
-. Muz = -1091.81 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 34.62 Deg. [Clause 5.8.3.4.2]
-. betay = 2.18

( ). Compute shear strength of concrete.
-. Vuz = 284.77 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 727.45 kN.
-. phiVcz = phi * Vcz = 654.70 kN.

-. Vuy = 499.18 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 683.29 kN.
-. phiVcy = phi * Vcy = 614.96 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.245 m.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.245 m.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 569.91 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 4236.78 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 569.91 kN.
-. phiVsz = phi*Vsz = 512.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 556.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4280.93 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 556.73 kN.
-. phiVsy = phi*Vsy = 501.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 574.693 kN.
-. Vr = 1116.021 kN.
-. Ratio = Vu / Vr = 0.515 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 556.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 569.91 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129005,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1686.90       507.68       467.10       830.72       610.33
           ---------------------------------------------------------------------------
           DL+LL+Others    -1686.90       507.68       467.10       830.72       610.33
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3525.264 kN.
          -. Mry        =      1060.678 kN-m.
          -. Mrz        =      1740.224 kN-m.
          -. Mr         =      2037.994 kN-m.
          -. Pu/Pr      =   0.479  --->  O.K !
          -. Muy/Mry    =   0.479  --->  O.K !
          -. Muz/Mrz    =   0.477  --->  O.K !
          -. Mu/Mr      =   0.479  --->  O.K !
          -. Ratio      =   0.479  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2926.58 kN.
          -. Vuz    =        247.57 kN.
          -. Muy    =       -499.45 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.45
```

-. Vuy = 461.46 kN.
-. Muz = -846.57 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 34.05 Deg. [Clause 5.8.3.4.2]
-. betay = 2.30

( ). Compute shear strength of concrete.
-. Vuz = 247.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 767.39 kN.
-. phiVcz = phi * Vcz = 690.65 kN.

-. Vuy = 461.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 723.06 kN.
-. phiVcy = phi * Vcy = 650.75 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.245 m.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.245 m.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 580.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 4196.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 580.84 kN.
-. phiVsz = phi*Vsz = 522.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 568.66 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4241.17 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 568.66 kN.
-. phiVsy = phi*Vsy = 511.79 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 523.676 kN.
-. Vr = 1162.546 kN.
-. Ratio = Vu / Vr = 0.450 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 568.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 580.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =1.4572e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =1.5117e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =1.5117e-005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129006,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1678.95       467.10       446.12       610.33       409.76
           ---------------------------------------------------------------------------
           DL+LL+Others    -1678.95       467.10       446.12       610.33       409.76
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4122.176 kN.
          -. Mry        =      1149.704 kN-m.
          -. Mrz        =      1495.109 kN-m.
          -. Mr         =      1886.046 kN-m.
          -. Pu/Pr      =   0.407  --->  O.K !
          -. Muy/Mry    =   0.406  --->  O.K !
          -. Muz/Mrz    =   0.408  --->  O.K !
          -. Mu/Mr      =   0.408  --->  O.K !
          -. Ratio      =   0.408  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2938.53 kN.
          -. Vuz    =        211.22 kN.
          -. Muy    =       -466.14 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.57
```

```
          -. Vuy    =       422.54 kN.
          -. Muz    =      -620.40 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.55 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.43

     ( ). Compute shear strength of concrete.
          -. Vuz       =      211.22 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      806.65 kN.
          -. phiVcz    = phi * Vcz =      725.98 kN.

          -. Vuy       =      422.54 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      762.40 kN.
          -. phiVcy    = phi * Vcy =      686.16 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      590.78 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4157.58 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      590.78 kN.
          -. phiVsz   = phi*Vsz =      531.70 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      579.53 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4201.83 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      579.53 kN.
          -. phiVsy   = phi*Vsy =      521.57 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     472.388 kN.
          -. Vr       =    1207.730 kN.
          -. Ratio    = Vu / Vr = 0.391  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 524.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 524.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0009 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129007,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -541.96       911.43       954.57       432.88       350.72
           ---------------------------------------------------------------------------
           DL+LL+Others     -541.96       911.43       954.57       432.88       350.72
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1347.949 kN.
          -. Mry        =      2392.052 kN-m.
          -. Mrz        =       879.068 kN-m.
          -. Mr         =      2548.465 kN-m.
          -. Pu/Pr      =   0.402  --->  O.K !
          -. Muy/Mry    =   0.399  --->  O.K !
          -. Muz/Mrz    =   0.399  --->  O.K !
          -. Mu/Mr      =   0.402  --->  O.K !
          -. Ratio      =   0.402  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2950.46 kN.
          -. Vuz    =        176.23 kN.
          -. Muy    =       -451.45 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.68 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.68
```

```
          -. Vuy    =       382.92 kN.
          -. Muz    =      -414.63 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54

     ( ). Compute shear strength of concrete.
          -. Vuz       =     176.23 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     841.78 kN.
          -. phiVcz    = phi * Vcz =     757.60 kN.

          -. Vuy       =     382.92 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     797.80 kN.
          -. phiVcy    = phi * Vcy =     718.02 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      599.06 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4122.45 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      599.06 kN.
          -. phiVsz   = phi*Vsz =      539.16 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      588.61 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4166.43 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      588.61 kN.
          -. phiVsy   = phi*Vsy =      529.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     421.526 kN.
          -. Vr       =    1247.761 kN.
          -. Ratio    = Vu / Vr = 0.338  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 468.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 468.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0016 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129008,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -533.79       954.57       982.40       350.72       301.65
           ---------------------------------------------------------------------------
           DL+LL+Others     -533.79       954.57       982.40       350.72       301.65
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1333.958 kN.
          -. Mry        =      2437.334 kN-m.
          -. Mrz        =       752.555 kN-m.
          -. Mr         =      2550.870 kN-m.
          -. Pu/Pr      =   0.400  --->  O.K !
          -. Muy/Mry    =   0.403  --->  O.K !
          -. Muz/Mrz    =   0.401  --->  O.K !
          -. Mu/Mr      =   0.403  --->  O.K !
          -. Ratio      =   0.403  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2962.39 kN.
          -. Vuz    =        143.25 kN.
          -. Muy    =       -456.92 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.76
```

```
          -. Vuy    =       343.16 kN.
          -. Muz    =      -233.26 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.87 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.62

     ( ). Compute shear strength of concrete.
          -. Vuz       =     143.25 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     867.18 kN.
          -. phiVcz    = phi * Vcz =     780.46 kN.

          -. Vuy       =     343.16 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     823.51 kN.
          -. phiVcy    = phi * Vcy =     741.16 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      604.73 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4097.05 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      604.73 kN.
          -. phiVsz   = phi*Vsz =      544.25 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      594.82 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4140.71 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      594.82 kN.
          -. phiVsy   = phi*Vsy =      535.34 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     371.861 kN.
          -. Vr       =    1276.504 kN.
          -. Ratio    = Vu / Vr = 0.291  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 413.18 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 413.18 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129009,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -525.62       982.40       994.98       301.65       312.35
           ------------------------------------------------------------------------------
            DL+LL+Others     -525.62       982.40       994.98       301.65       312.35
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1280.973 kN.
          -. Mry        =      2442.634 kN-m.
          -. Mrz        =       771.917 kN-m.
          -. Mr         =      2561.702 kN-m.
          -. Pu/Pr      =   0.410  --->  O.K !
          -. Muy/Mry    =   0.407  --->  O.K !
          -. Muz/Mrz    =   0.405  --->  O.K !
          -. Mu/Mr      =   0.410  --->  O.K !
          -. Ratio      =   0.410  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2985.87 kN.
          -. Vuz    =        113.60 kN.
          -. Muy    =       -502.04 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75
```

```
          -. Vuy    =        303.83 kN.
          -. Muz    =       -252.06 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61

     ( ). Compute shear strength of concrete.
          -. Vuz       =      113.60 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      862.62 kN.
          -. phiVcz    = phi * Vcz =      776.36 kN.

          -. Vuy       =      303.83 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      818.89 kN.
          -. phiVcy    = phi * Vcy =      737.00 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      603.73 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4101.61 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      603.73 kN.
          -. phiVsz   = phi*Vsz =      543.36 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      593.73 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4145.33 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      593.73 kN.
          -. phiVsy   = phi*Vsy =      534.36 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     324.372 kN.
          -. Vr       =    1271.359 kN.
          -. Ratio    = Vu / Vr = 0.255  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 360.41 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 360.41 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0020 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129010,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -525.77       994.98       990.90       312.35       326.18
           ---------------------------------------------------------------------------
           DL+LL+Others     -525.77       994.98       990.90       312.35       326.18
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1280.973 kN.
          -. Mry        =      2442.634 kN-m.
          -. Mrz        =       771.917 kN-m.
          -. Mr         =      2561.702 kN-m.
          -. Pu/Pr      =   0.410  --->  O.K !
          -. Muy/Mry    =   0.407  --->  O.K !
          -. Muz/Mrz    =   0.405  --->  O.K !
          -. Mu/Mr      =   0.410  --->  O.K !
          -. Ratio      =   0.410  --->  O.K !

 =======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 =======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2997.76 kN.
          -. Vuz    =         96.92 kN.
          -. Muy    =       -523.58 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.57 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.72
```

```
          -. Vuy    =       265.49 kN.
          -. Muz    =      -357.86 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.58

     ( ). Compute shear strength of concrete.
          -. Vuz       =      96.92 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      853.52 kN.
          -. phiVcz    = phi * Vcz =      768.17 kN.

          -. Vuy       =     265.49 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      809.68 kN.
          -. phiVcy    = phi * Vcy =      728.71 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      601.71 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4110.70 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      601.71 kN.
          -. phiVsz   = phi*Vsz =      541.54 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      591.52 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4154.55 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      591.52 kN.
          -. phiVsy   = phi*Vsy =      532.36 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     282.633 kN.
          -. Vr       =    1261.074 kN.
          -. Ratio    = Vu / Vr = 0.224  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 314.04 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 314.04 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129011,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -517.58       990.90       971.74       326.18       337.46
           ---------------------------------------------------------------------------
           DL+LL+Others     -517.58       990.90       971.74       326.18       337.46
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1278.165 kN.
          -. Mry        =      2431.613 kN-m.
          -. Mrz        =       806.194 kN-m.
          -. Mr         =      2561.775 kN-m.
          -. Pu/Pr      =   0.405  --->  O.K !
          -. Muy/Mry    =   0.408  --->  O.K !
          -. Muz/Mrz    =   0.405  --->  O.K !
          -. Mu/Mr      =   0.408  --->  O.K !
          -. Ratio      =   0.408  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3009.65 kN.
          -. Vuz    =         89.33 kN.
          -. Muy    =       -538.37 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.69
```

-. Vuy = 228.74 kN.
-. Muz = -449.91 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 33.11 Deg. [Clause 5.8.3.4.2]
-. betay = 2.55

( ). Compute shear strength of concrete.
-. Vuz = 89.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 844.93 kN.
-. phiVcz = phi * Vcz = 760.44 kN.

-. Vuy = 228.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 800.98 kN.
-. phiVcy = phi * Vcy = 720.88 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 599.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 4119.30 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 599.78 kN.
-. phiVsz = phi*Vsz = 539.80 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 589.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4163.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 589.39 kN.
-. phiVsy = phi*Vsy = 530.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 245.564 kN.
-. Vr = 1251.335 kN.
-. Ratio = Vu / Vr = 0.196 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 272.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 272.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129012,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -509.39       971.74       938.91       337.46       346.55
           ---------------------------------------------------------------------------
           DL+LL+Others     -509.39       971.74       938.91       337.46       346.55
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1276.165 kN.
          -. Mry        =      2418.049 kN-m.
          -. Mrz        =       846.307 kN-m.
          -. Mr         =      2561.874 kN-m.
          -. Pu/Pr      =   0.399  --->  O.K !
          -. Muy/Mry    =   0.402  --->  O.K !
          -. Muz/Mrz    =   0.399  --->  O.K !
          -. Mu/Mr      =   0.402  --->  O.K !
          -. Ratio      =   0.402  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3021.52 kN.
          -. Vuz    =         82.98 kN.
          -. Muy    =       -544.90 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.67
```

-. Vuy = 194.10 kN.
-. Muz = -528.00 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 33.18 Deg. [Clause 5.8.3.4.2]
-. betay = 2.53

( ). Compute shear strength of concrete.
-. Vuz = 82.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 838.07 kN.
-. phiVcz = phi * Vcz = 754.26 kN.

-. Vuy = 194.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 794.05 kN.
-. phiVcy = phi * Vcy = 714.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 598.21 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 4126.16 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 598.21 kN.
-. phiVsz = phi*Vsz = 538.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 587.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4170.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 587.67 kN.
-. phiVsy = phi*Vsy = 528.91 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 211.088 kN.
-. Vr = 1243.549 kN.
-. Ratio = Vu / Vr = 0.170 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 234.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 234.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0016 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129013,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1614.66       520.43       509.73       542.83       594.83
           ------------------------------------------------------------------------------
            DL+LL+Others    -1614.66       520.43       509.73       542.83       594.83
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3968.565 kN.
          -. Mry        =      1258.496 kN-m.
          -. Mrz        =      1466.152 kN-m.
          -. Mr         =      1932.204 kN-m.
          -. Pu/Pr      =   0.407  --->  O.K !
          -. Muy/Mry    =   0.405  --->  O.K !
          -. Muz/Mrz    =   0.406  --->  O.K !
          -. Mu/Mr      =   0.407  --->  O.K !
          -. Ratio      =   0.407  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1900.03 kN.
          -. Vuz    =        128.02 kN.
          -. Muy    =       -963.38 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78
```

```
          -. Vuy    =         95.53 kN.
          -. Muz    =       -331.72 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64

     ( ). Compute shear strength of concrete.
          -. Vuz       =      128.02 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      873.05 kN.
          -. phiVcz    = phi * Vcz =      785.75 kN.

          -. Vuy       =       95.53 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      829.48 kN.
          -. phiVcy    = phi * Vcy =      746.53 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      606.00 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4091.17 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      606.00 kN.
          -. phiVsz   = phi*Vsz =      545.40 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      596.22 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4134.75 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      596.22 kN.
          -. phiVsy   = phi*Vsy =      536.60 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     159.737 kN.
          -. Vr       =    1283.131 kN.
          -. Ratio    = Vu / Vr = 0.124  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 177.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 177.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129014,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1606.61       509.73       485.39       594.83       621.18
           ---------------------------------------------------------------------------
           DL+LL+Others    -1606.61       509.73       485.39       594.83       621.18
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3944.285 kN.
          -. Mry        =      1189.693 kN-m.
          -. Mrz        =      1526.261 kN-m.
          -. Mr         =      1935.159 kN-m.
          -. Pu/Pr      =   0.407  --->  O.K !
          -. Muy/Mry    =   0.408  --->  O.K !
          -. Muz/Mrz    =   0.407  --->  O.K !
          -. Mu/Mr      =   0.408  --->  O.K !
          -. Ratio      =   0.408  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1911.72 kN.
          -. Vuz    =        153.51 kN.
          -. Muy    =       -908.76 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81
```

```
          -. Vuy    =         72.50 kN.
          -. Muz    =       -331.91 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67

     ( ). Compute shear strength of concrete.
          -. Vuz       =      153.51 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      881.20 kN.
          -. phiVcz    = phi * Vcz =      793.08 kN.

          -. Vuy       =       72.50 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      837.75 kN.
          -. phiVcy    = phi * Vcy =      753.98 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      607.74 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4083.03 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      607.74 kN.
          -. phiVsz   = phi*Vsz =      546.97 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      598.14 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4126.47 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      598.14 kN.
          -. phiVsy   = phi*Vsy =      538.33 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     169.770 kN.
          -. Vr       =    1292.305 kN.
          -. Ratio    = Vu / Vr = 0.131  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 188.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 188.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129015,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1606.88       485.39       450.39       621.18       625.15
           ------------------------------------------------------------------------------
            DL+LL+Others    -1606.88       485.39       450.39       621.18       625.15
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3944.285 kN.
          -. Mry        =      1189.693 kN-m.
          -. Mrz        =      1526.261 kN-m.
          -. Mr         =      1935.159 kN-m.
          -. Pu/Pr      =   0.407  --->  O.K !
          -. Muy/Mry    =   0.408  --->  O.K !
          -. Muz/Mrz    =   0.407  --->  O.K !
          -. Mu/Mr      =   0.408  --->  O.K !
          -. Ratio      =   0.408  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1923.40 kN.
          -. Vuz    =        172.86 kN.
          -. Muy    =       -836.41 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.20 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.85
```

```
          -. Vuy    =        52.79 kN.
          -. Muz    =      -325.45 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.60 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71

     ( ). Compute shear strength of concrete.
          -. Vuz       =     172.86 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      893.26 kN.
          -. phiVcz    = phi * Vcz =      803.93 kN.

          -. Vuy       =      52.79 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      850.03 kN.
          -. phiVcy    = phi * Vcy =      765.03 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      610.28 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4070.97 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      610.28 kN.
          -. phiVsz   = phi*Vsz =      549.25 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      600.93 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4114.20 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      600.93 kN.
          -. phiVsy   = phi*Vsy =      540.84 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     180.741 kN.
          -. Vr       =    1305.866 kN.
          -. Ratio    = Vu / Vr = 0.138  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 200.82 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 200.82 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0006 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0006 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0006 m^2.
- As = 0.0261 m^2.
- As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129016,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1598.80       450.39       407.84       625.15       610.43
           ---------------------------------------------------------------------------
           DL+LL+Others    -1598.80       450.39       407.84       625.15       610.43
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3975.080 kN.
          -. Mry        =      1122.629 kN-m.
          -. Mrz        =      1560.513 kN-m.
          -. Mr         =      1922.368 kN-m.
          -. Pu/Pr      =   0.402  --->  O.K !
          -. Muy/Mry    =   0.401  --->  O.K !
          -. Muz/Mrz    =   0.401  --->  O.K !
          -. Mu/Mr      =   0.402  --->  O.K !
          -. Ratio      =   0.402  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1935.09 kN.
          -. Vuz    =        184.83 kN.
          -. Muy    =       -751.85 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90
```

```
          -. Vuy    =        48.67 kN.
          -. Muz    =      -313.07 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.45 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76

     ( ). Compute shear strength of concrete.
          -. Vuz       =     184.83 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      908.60 kN.
          -. phiVcz    = phi * Vcz =      817.74 kN.

          -. Vuy       =      48.67 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      865.68 kN.
          -. phiVcy    = phi * Vcy =      779.11 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      613.43 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4055.63 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      613.43 kN.
          -. phiVsz   = phi*Vsz =      552.09 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      604.40 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4098.55 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      604.40 kN.
          -. phiVsy   = phi*Vsy =      543.96 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     191.131 kN.
          -. Vr       =    1323.069 kN.
          -. Ratio    = Vu / Vr = 0.144  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 212.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 212.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129017,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1590.72       407.84       360.74       610.43       580.82
           ---------------------------------------------------------------------------
           DL+LL+Others    -1590.72       407.84       360.74       610.43       580.82
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4080.120 kN.
          -. Mry        =      1050.560 kN-m.
          -. Mrz        =      1572.327 kN-m.
          -. Mr         =      1891.002 kN-m.
          -. Pu/Pr      =   0.390  --->  O.K !
          -. Muy/Mry    =   0.388  --->  O.K !
          -. Muz/Mrz    =   0.388  --->  O.K !
          -. Mu/Mr      =   0.390  --->  O.K !
          -. Ratio      =   0.390  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1946.76 kN.
          -. Vuz    =        188.55 kN.
          -. Muy    =       -660.31 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96
```

```
          -. Vuy    =        53.19 kN.
          -. Muz    =      -295.79 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.28 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.82

     ( ). Compute shear strength of concrete.
          -. Vuz       =     188.55 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      927.17 kN.
          -. phiVcz    = phi * Vcz =      834.45 kN.

          -. Vuy       =      53.19 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      884.67 kN.
          -. phiVcy    = phi * Vcy =      796.20 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      617.13 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4037.06 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      617.13 kN.
          -. phiVsz   = phi*Vsz =      555.42 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      608.48 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4079.56 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      608.48 kN.
          -. phiVsy   = phi*Vsy =      547.63 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     195.905 kN.
          -. Vr       =    1343.835 kN.
          -. Ratio    = Vu / Vr = 0.146  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 217.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 217.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-2.1652e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-1.5729e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-1.5729e-005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129018,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1582.62       360.74       311.82       580.82       540.09
           ------------------------------------------------------------------------------
            DL+LL+Others    -1582.62       360.74       311.82       580.82       540.09
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4261.142 kN.
          -. Mry        =       974.789 kN-m.
          -. Mrz        =      1562.757 kN-m.
          -. Mr         =      1841.853 kN-m.
          -. Pu/Pr      =   0.371  --->  O.K !
          -. Muy/Mry    =   0.370  --->  O.K !
          -. Muz/Mrz    =   0.372  --->  O.K !
          -. Mu/Mr      =   0.372  --->  O.K !
          -. Ratio      =   0.372  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1958.43 kN.
          -. Vuz    =        184.53 kN.
          -. Muy    =       -566.50 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.74 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.02
```

```
          -. Vuy    =        56.20 kN.
          -. Muz    =      -274.76 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.89

     ( ). Compute shear strength of concrete.
          -. Vuz       =     184.53 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      948.57 kN.
          -. phiVcz    = phi * Vcz =      853.71 kN.

          -. Vuy       =      56.20 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      906.63 kN.
          -. phiVcy    = phi * Vcy =      815.96 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      621.26 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4015.66 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      621.26 kN.
          -. phiVsz   = phi*Vsz =      559.13 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      613.03 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4057.60 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      613.03 kN.
          -. phiVsy   = phi*Vsy =      551.73 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     192.900 kN.
          -. Vr       =    1367.688 kN.
          -. Ratio    = Vu / Vr = 0.141  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 214.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 214.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0004 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129019,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1574.51       311.82       263.51       540.09       491.81
           ---------------------------------------------------------------------------
           DL+LL+Others    -1574.51       311.82       263.51       540.09       491.81
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4486.855 kN.
          -. Mry        =       889.750 kN-m.
          -. Mrz        =      1541.083 kN-m.
          -. Mr         =      1779.492 kN-m.
          -. Pu/Pr      =   0.351  --->  O.K !
          -. Muy/Mry    =   0.350  --->  O.K !
          -. Muz/Mrz    =   0.350  --->  O.K !
          -. Mu/Mr      =   0.351  --->  O.K !
          -. Ratio      =   0.351  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1970.09 kN.
          -. Vuz    =        173.85 kN.
          -. Muy    =       -474.53 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.10
```

```
          -. Vuy    =        57.47 kN.
          -. Muz    =      -251.12 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.88 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.97

     ( ). Compute shear strength of concrete.
          -. Vuz       =     173.85 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      971.91 kN.
          -. phiVcz    = phi * Vcz =      874.72 kN.

          -. Vuy       =      57.47 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      930.65 kN.
          -. phiVcy    = phi * Vcy =      837.59 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      625.59 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3992.32 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      625.59 kN.
          -. phiVsz   = phi*Vsz =      563.03 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      617.81 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4033.57 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      617.81 kN.
          -. phiVsy   = phi*Vsy =      556.03 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     183.104 kN.
          -. Vr       =    1393.618 kN.
          -. Ratio    = Vu / Vr = 0.131  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 203.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 203.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0008 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129020,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1566.39       263.51       217.81       491.81       439.30
           ---------------------------------------------------------------------------
           DL+LL+Others    -1566.39       263.51       217.81       491.81       439.30
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4801.988 kN.
          -. Mry        =       792.252 kN-m.
          -. Mrz        =      1497.092 kN-m.
          -. Mr         =      1693.797 kN-m.
          -. Pu/Pr      =   0.326  --->  O.K !
          -. Muy/Mry    =   0.333  --->  O.K !
          -. Muz/Mrz    =   0.329  --->  O.K !
          -. Mu/Mr      =   0.333  --->  O.K !
          -. Ratio      =   0.333  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1981.75 kN.
          -. Vuz    =        157.79 kN.
          -. Muy    =       -387.81 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.18
```

```
          -. Vuy    =         56.92 kN.
          -. Muz    =       -226.00 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.05

     ( ). Compute shear strength of concrete.
          -. Vuz       =      157.79 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      996.23 kN.
          -. phiVcz    = phi * Vcz =      896.61 kN.

          -. Vuy       =       56.92 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      955.79 kN.
          -. phiVcy    = phi * Vcy =      860.21 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      629.93 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3967.99 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      629.93 kN.
          -. phiVsz   = phi*Vsz =      566.94 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      622.61 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4008.43 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      622.61 kN.
          -. phiVsy   = phi*Vsy =      560.35 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     167.746 kN.
          -. Vr       =    1420.568 kN.
          -. Ratio    = Vu / Vr = 0.118  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 186.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 186.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129021,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1558.25       217.81       176.36       439.30       385.50
           ------------------------------------------------------------------------------
            DL+LL+Others    -1558.25       217.81       176.36       439.30       385.50
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5091.886 kN.
          -. Mry        =       712.011 kN-m.
          -. Mrz        =      1445.362 kN-m.
          -. Mr         =      1611.220 kN-m.
          -. Pu/Pr      =   0.306  --->  O.K !
          -. Muy/Mry    =   0.306  --->  O.K !
          -. Muz/Mrz    =   0.304  --->  O.K !
          -. Mu/Mr      =   0.306  --->  O.K !
          -. Ratio      =   0.306  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3116.24 kN.
          -. Vuz    =         87.79 kN.
          -. Muy    =       -229.54 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.18 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86
```

```
          -. Vuy    =       106.06 kN.
          -. Muz    =      -428.13 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.57 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.72

     ( ). Compute shear strength of concrete.
          -. Vuz       =      87.79 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      896.08 kN.
          -. phiVcz    = phi * Vcz =      806.47 kN.

          -. Vuy       =     106.06 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      852.90 kN.
          -. phiVcy    = phi * Vcy =      767.61 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      610.86 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4068.15 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      610.86 kN.
          -. phiVsz   = phi*Vsz =      549.78 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      601.58 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4111.32 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      601.58 kN.
          -. phiVsy   = phi*Vsy =      541.42 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     137.675 kN.
          -. Vr       =    1309.030 kN.
          -. Ratio    = Vu / Vr = 0.105  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 152.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 152.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129022,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1550.10       176.36       140.38       385.50       332.97
           ------------------------------------------------------------------------------
            DL+LL+Others    -1550.10       176.36       140.38       385.50       332.97
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5479.769 kN.
          -. Mry        =       627.354 kN-m.
          -. Mrz        =      1355.392 kN-m.
          -. Mr         =      1493.539 kN-m.
          -. Pu/Pr      =   0.283  --->  O.K !
          -. Muy/Mry    =   0.281  --->  O.K !
          -. Muz/Mrz    =   0.284  --->  O.K !
          -. Mu/Mr      =   0.284  --->  O.K !
          -. Ratio      =   0.284  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3127.99 kN.
          -. Vuz    =         76.18 kN.
          -. Muy    =       -185.97 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90
```

```
          -. Vuy    =       103.23 kN.
          -. Muz    =      -375.78 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.77

     ( ). Compute shear strength of concrete.
          -. Vuz       =      76.18 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      911.00 kN.
          -. phiVcz    = phi * Vcz =      819.90 kN.

          -. Vuy       =     103.23 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      868.13 kN.
          -. phiVcy    = phi * Vcy =      781.32 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      613.91 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4053.23 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      613.91 kN.
          -. phiVsz   = phi*Vsz =      552.52 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      604.93 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4096.10 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      604.93 kN.
          -. phiVsy   = phi*Vsy =      544.44 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     128.294 kN.
          -. Vr       =    1325.756 kN.
          -. Ratio    = Vu / Vr = 0.097  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 142.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 142.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129023,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1541.94       140.38       109.73       332.97       283.32
           ---------------------------------------------------------------------------
           DL+LL+Others    -1541.94       140.38       109.73       332.97       283.32
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5861.311 kN.
          -. Mry        =       544.593 kN-m.
          -. Mrz        =      1265.411 kN-m.
          -. Mr         =      1377.624 kN-m.
          -. Pu/Pr      =   0.263  --->  O.K !
          -. Muy/Mry    =   0.258  --->  O.K !
          -. Muz/Mrz    =   0.263  --->  O.K !
          -. Mu/Mr      =   0.263  --->  O.K !
          -. Ratio      =   0.263  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3139.72 kN.
          -. Vuz    =         64.93 kN.
          -. Muy    =       -148.11 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.92 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95
```

```
          -. Vuy    =         97.38 kN.
          -. Muz    =       -324.65 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.29 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.82

     ( ). Compute shear strength of concrete.
          -. Vuz       =       64.93 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      925.81 kN.
          -. phiVcz    = phi * Vcz =      833.23 kN.

          -. Vuy       =       97.38 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      883.28 kN.
          -. phiVcy    = phi * Vcy =      794.95 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      616.86 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4038.42 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      616.86 kN.
          -. phiVsz   = phi*Vsz =      555.18 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      608.18 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4080.95 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      608.18 kN.
          -. phiVsy   = phi*Vsy =      547.37 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     117.043 kN.
          -. Vr       =    1342.316 kN.
          -. Ratio    = Vu / Vr = 0.087  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 130.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 130.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129024,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1533.77       109.73        83.64       283.32       237.11
           ------------------------------------------------------------------------------
            DL+LL+Others    -1533.77       109.73        83.64       283.32       237.11
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -6314.842 kN.
          -. Mry        =       453.077 kN-m.
          -. Mrz        =      1154.275 kN-m.
          -. Mr         =      1240.012 kN-m.
          -. Pu/Pr      =   0.243  --->  O.K !
          -. Muy/Mry    =   0.242  --->  O.K !
          -. Muz/Mrz    =   0.245  --->  O.K !
          -. Mu/Mr      =   0.245  --->  O.K !
          -. Ratio      =   0.245  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3151.44 kN.
          -. Vuz    =         55.30 kN.
          -. Muy    =       -115.83 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.81 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00
```

```
          -. Vuy    =         90.55 kN.
          -. Muz    =       -276.30 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86

     ( ). Compute shear strength of concrete.
          -. Vuz       =       55.30 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      939.84 kN.
          -. phiVcz    = phi * Vcz =      845.86 kN.

          -. Vuy       =       90.55 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      897.66 kN.
          -. phiVcy    = phi * Vcy =      807.90 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      619.59 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4024.38 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      619.59 kN.
          -. phiVsz   = phi*Vsz =      557.63 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      611.19 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4066.56 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      611.19 kN.
          -. phiVsy   = phi*Vsy =      550.07 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     106.099 kN.
          -. Vr       =    1357.969 kN.
          -. Ratio    = Vu / Vr = 0.078  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 117.89 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 117.89 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129025,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1525.58        83.64        62.13       237.11       195.08
           ---------------------------------------------------------------------------
           DL+LL+Others    -1525.58        83.64        62.13       237.11       195.08
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -6731.584 kN.
          -. Mry        =       369.455 kN-m.
          -. Mrz        =      1040.861 kN-m.
          -. Mr         =      1104.485 kN-m.
          -. Pu/Pr      =   0.227  --->  O.K !
          -. Muy/Mry    =   0.226  --->  O.K !
          -. Muz/Mrz    =   0.228  --->  O.K !
          -. Mu/Mr      =   0.228  --->  O.K !
          -. Ratio      =   0.228  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3163.15 kN.
          -. Vuz    =         45.64 kN.
          -. Muy    =        -88.35 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04
```

```
          -. Vuy    =        82.28 kN.
          -. Muz    =      -231.28 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91

     ( ). Compute shear strength of concrete.
          -. Vuz       =       45.64 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      953.23 kN.
          -. phiVcz    = phi * Vcz =      857.91 kN.

          -. Vuy       =       82.28 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      911.42 kN.
          -. phiVcy    = phi * Vcy =      820.28 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      622.13 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4010.99 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      622.13 kN.
          -. phiVsz   = phi*Vsz =      559.92 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      614.00 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4052.81 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      614.00 kN.
          -. phiVsy   = phi*Vsy =      552.60 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      94.089 kN.
          -. Vr       =    1372.877 kN.
          -. Ratio    = Vu / Vr = 0.069  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 104.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 104.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0040 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129026,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1517.38        62.13        45.05       195.08       157.70
           ------------------------------------------------------------------------------
            DL+LL+Others    -1517.38        62.13        45.05       195.08       157.70
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -7152.228 kN.
          -. Mry        =       295.886 kN-m.
          -. Mrz        =       915.893 kN-m.
          -. Mr         =       962.501 kN-m.
          -. Pu/Pr      =   0.212  --->  O.K !
          -. Muy/Mry    =   0.210  --->  O.K !
          -. Muz/Mrz    =   0.213  --->  O.K !
          -. Mu/Mr      =   0.213  --->  O.K !
          -. Ratio      =   0.213  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3174.84 kN.
          -. Vuz    =         36.30 kN.
          -. Muy    =        -65.67 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.61 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.08
```

```
          -. Vuy    =         73.13 kN.
          -. Muz    =       -190.33 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95

     ( ). Compute shear strength of concrete.
          -. Vuz       =       36.30 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      965.66 kN.
          -. phiVcz    = phi * Vcz =      869.09 kN.

          -. Vuy       =       73.13 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      924.21 kN.
          -. phiVcy    = phi * Vcy =      831.79 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      624.45 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3998.57 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      624.45 kN.
          -. phiVsz   = phi*Vsz =      562.00 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      616.55 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4040.01 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      616.55 kN.
          -. phiVsy   = phi*Vsy =      554.89 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      81.647 kN.
          -. Vr       =    1386.687 kN.
          -. Ratio    = Vu / Vr = 0.059  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 90.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 90.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129027,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1509.17        45.05        31.37       157.70       124.28
           ---------------------------------------------------------------------------
           DL+LL+Others    -1509.17        45.05        31.37       157.70       124.28
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -7549.327 kN.
          -. Mry        =       226.303 kN-m.
          -. Mrz        =       797.464 kN-m.
          -. Mr         =       828.952 kN-m.
          -. Pu/Pr      =   0.200  --->  O.K !
          -. Muy/Mry    =   0.199  --->  O.K !
          -. Muz/Mrz    =   0.198  --->  O.K !
          -. Mu/Mr      =   0.200  --->  O.K !
          -. Ratio      =   0.200  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3186.52 kN.
          -. Vuz    =         29.15 kN.
          -. Muy    =        -47.65 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.11
```

-. Vuy = 65.33 kN.
-. Muz = -153.89 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 31.85 Deg. [Clause 5.8.3.4.2]
-. betay = 2.98

( ). Compute shear strength of concrete.
-. Vuz = 29.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 976.48 kN.
-. phiVcz = phi * Vcz = 878.83 kN.

-. Vuy = 65.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 935.37 kN.
-. phiVcy = phi * Vcy = 841.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 626.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3987.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 626.42 kN.
-. phiVsz = phi*Vsz = 563.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 618.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4028.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 618.73 kN.
-. phiVsy = phi*Vsy = 556.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 71.544 kN.
-. Vr = 1398.687 kN.
-. Ratio = Vu / Vr = 0.051 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 79.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 79.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129028,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1500.94        31.37        20.15       124.28        93.93
           ------------------------------------------------------------------------------
            DL+LL+Others    -1500.94        31.37        20.15       124.28        93.93
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -7991.994 kN.
          -. Mry        =       159.349 kN-m.
          -. Mrz        =       659.543 kN-m.
          -. Mr         =       678.520 kN-m.
          -. Pu/Pr      =   0.188  --->  O.K !
          -. Muy/Mry    =   0.197  --->  O.K !
          -. Muz/Mrz    =   0.188  --->  O.K !
          -. Mu/Mr      =   0.197  --->  O.K !
          -. Ratio      =   0.197  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3198.19 kN.
          -. Vuz    =         24.16 kN.
          -. Muy    =        -33.20 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.14
```

```
          -. Vuy    =         59.35 kN.
          -. Muz    =       -121.31 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01

     ( ). Compute shear strength of concrete.
          -. Vuz       =       24.16 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      985.78 kN.
          -. phiVcz    = phi * Vcz =      887.20 kN.

          -. Vuy       =       59.35 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      944.98 kN.
          -. phiVcy    = phi * Vcy =      850.48 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      628.09 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3978.45 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      628.09 kN.
          -. phiVsz   = phi*Vsz =      565.28 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      620.57 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4019.25 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      620.57 kN.
          -. phiVsy   = phi*Vsy =      558.52 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      64.085 kN.
          -. Vr       =    1408.996 kN.
          -. Ratio    = Vu / Vr = 0.045  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 71.21 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 71.21 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129029,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3221.41       -21.34       -13.29       -91.71       -64.94
           ------------------------------------------------------------------------------
            DL+LL+Others     3221.41       -21.34       -13.29       -91.71       -64.94
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.29 kN-m.
           -. End Moments (My2) =       21.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       64.94 kN-m.
          -. End Moments (Mz2) =       91.71 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -64.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -64.94 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        70.335 kN-m.
          -. Mrz        =       346.103 kN-m.
          -. Mr         =       353.177 kN-m.
          -. Pu/Pr      =   0.188  --->  O.K !
          -. Muy/Mry    =   0.189  --->  O.K !
          -. Muz/Mrz    =   0.188  --->  O.K !
          -. Mu/Mr      =   0.189  --->  O.K !
          -. Ratio      =   0.189  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3209.85 kN.
          -. Vuz    =         19.87 kN.
          -. Muy    =        -21.34 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.17

          -. Vuy    =         53.69 kN.
          -. Muz    =        -91.71 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.04
```

( ). Compute shear strength of concrete.
-. Vuz = 19.87 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 994.17 kN.
-. phiVcz = phi * Vcz = 894.75 kN.

-. Vuy = 53.69 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 953.66 kN.
-. phiVcy = phi * Vcy = 858.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 629.57 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3970.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 629.57 kN.
-. phiVsz = phi*Vsz = 566.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 622.21 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4010.57 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 622.21 kN.
-. phiVsy = phi*Vsy = 559.99 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 57.251 kN.
-. Vr = 1418.286 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 63.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 63.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0047 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                  Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129030,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3233.06       -13.29        -8.75       -64.94       -40.77
           ------------------------------------------------------------------------------
            DL+LL+Others     3233.06       -13.29        -8.75       -64.94       -40.77
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.75 kN-m.
           -. End Moments (My2) =       13.29 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.75 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.75 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       40.77 kN-m.
          -. End Moments (Mz2) =       64.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -40.77 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -40.77 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        46.279 kN-m.
          -. Mrz        =       216.501 kN-m.
          -. Mr         =       221.392 kN-m.
          -. Pu/Pr      =   0.188  --->  O.K !
          -. Muy/Mry    =   0.189  --->  O.K !
          -. Muz/Mrz    =   0.188  --->  O.K !
          -. Mu/Mr      =   0.189  --->  O.K !
          -. Ratio      =   0.189  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3221.49 kN.
          -. Vuz    =         16.33 kN.
          -. Muy    =        -13.29 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.35 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.19

          -. Vuy    =         48.51 kN.
          -. Muz    =        -64.94 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.06
```

( ). Compute shear strength of concrete.
-. Vuz = 16.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1001.57 kN.
-. phiVcz = phi * Vcz = 901.41 kN.

-. Vuy = 48.51 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 961.32 kN.
-. phiVcy = phi * Vcy = 865.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 630.86 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3962.66 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 630.86 kN.
-. phiVsz = phi*Vsz = 567.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 623.64 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4002.91 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 623.64 kN.
-. phiVsy = phi*Vsy = 561.28 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 51.181 kN.
-. Vr = 1426.469 kN.
-. Ratio = Vu / Vr = 0.036 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 56.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 56.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0048 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129031,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3244.69        -8.75        -5.83       -40.77       -23.28
           ------------------------------------------------------------------------------
            DL+LL+Others     3244.69        -8.75        -5.83       -40.77       -23.28
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        5.83 kN-m.
           -. End Moments (My2) =        8.75 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -5.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -5.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       23.28 kN-m.
          -. End Moments (Mz2) =       40.77 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -23.28 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -23.28 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0333
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     17164.865 kN.
           -. Pr         =     17164.865 kN.
           -. Mry        =        30.791 kN-m.
           -. Mrz        =       123.137 kN-m.
           -. Mr         =       126.928 kN-m.
           -. Pu/Pr      =   0.189  --->  O.K !
           -. Muy/Mry    =   0.189  --->  O.K !
           -. Muz/Mrz    =   0.189  --->  O.K !
           -. Mu/Mr      =   0.189  --->  O.K !
           -. Ratio      =   0.189  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0003 m^2.
           -. Pu     =       3233.12 kN.
           -. Vuz    =          8.39 kN.
           -. Muy    =         -8.75 kN-m.
           -. bvz    =   1.00 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
           -. thetaz =  31.29 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.22

           -. Vuy    =         35.09 kN.
           -. Muz    =        -40.77 kN-m.
           -. bvy    =   1.00 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
           -. thetay =  31.58 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.09
```

( ). Compute shear strength of concrete.
-. Vuz = 8.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1009.94 kN.
-. phiVcz = phi * Vcz = 908.95 kN.

-. Vuy = 35.09 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 970.01 kN.
-. phiVcy = phi * Vcy = 873.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 632.31 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3954.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 632.31 kN.
-. phiVsz = phi*Vsz = 569.08 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 625.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3994.22 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 625.24 kN.
-. phiVsy = phi*Vsy = 562.72 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 36.082 kN.
-. Vr = 1435.724 kN.
-. Ratio = Vu / Vr = 0.025 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 40.09 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 40.09 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0050 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129032,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3256.30        -5.83        -3.98       -23.28       -11.46
           ------------------------------------------------------------------------------
            DL+LL+Others     3256.30        -5.83        -3.98       -23.28       -11.46
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.98 kN-m.
           -. End Moments (My2) =        5.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.98 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.98 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       11.46 kN-m.
          -. End Moments (Mz2) =       23.28 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -11.46 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -11.46 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        20.999 kN-m.
          -. Mrz        =        60.434 kN-m.
          -. Mr         =        63.978 kN-m.
          -. Pu/Pr      =   0.190  --->  O.K !
          -. Muy/Mry    =   0.190  --->  O.K !
          -. Muz/Mrz    =   0.190  --->  O.K !
          -. Mu/Mr      =   0.190  --->  O.K !
          -. Ratio      =   0.190  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3244.74 kN.
          -. Vuz    =          4.96 kN.
          -. Muy    =         -5.83 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.25 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.24

          -. Vuy    =         23.67 kN.
          -. Muz    =        -23.28 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.53 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.11
```

( ). Compute shear strength of concrete.
-. Vuz = 4.96 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1015.94 kN.
-. phiVcz = phi * Vcz = 914.35 kN.

-. Vuy = 23.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 976.24 kN.
-. phiVcy = phi * Vcy = 878.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 633.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3948.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 633.33 kN.
-. phiVsz = phi*Vsz = 570.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 626.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3987.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 626.37 kN.
-. phiVsy = phi*Vsy = 563.74 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 24.184 kN.
-. Vr = 1442.352 kN.
-. Ratio = Vu / Vr = 0.017 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 26.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 26.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0051 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0051 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0051 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129033,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3267.91        -3.98        -2.38       -11.46        -4.32
           ------------------------------------------------------------------------------
            DL+LL+Others     3267.91        -3.98        -2.38       -11.46        -4.32
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.38 kN-m.
           -. End Moments (My2) =        3.98 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.32 kN-m.
          -. End Moments (Mz2) =       11.46 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.32 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.32 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        12.530 kN-m.
          -. Mrz        =        22.689 kN-m.
          -. Mr         =        25.919 kN-m.
          -. Pu/Pr      =   0.190  --->  O.K !
          -. Muy/Mry    =   0.190  --->  O.K !
          -. Muz/Mrz    =   0.191  --->  O.K !
          -. Mu/Mr      =   0.191  --->  O.K !
          -. Ratio      =   0.191  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3267.91 kN.
          -. Vuz    =          3.71 kN.
          -. Muy    =         -2.38 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.25

          -. Vuy    =         14.30 kN.
          -. Muz    =         -4.32 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.12
```

( ). Compute shear strength of concrete.
-. Vuz = 3.71 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1019.18 kN.
-. phiVcz = phi * Vcz = 917.26 kN.

-. Vuy = 14.30 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 979.60 kN.
-. phiVcy = phi * Vcy = 881.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 633.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3945.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 633.88 kN.
-. phiVsz = phi*Vsz = 570.49 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 626.98 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3984.63 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 626.98 kN.
-. phiVsy = phi*Vsy = 564.28 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 14.773 kN.
-. Vr = 1445.920 kN.
-. Ratio = Vu / Vr = 0.010 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 16.41 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 16.41 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0052 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129034,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3279.50        -2.38        -0.83        -4.32        -0.84
           ------------------------------------------------------------------------------
            DL+LL+Others     3279.50        -2.38        -0.83        -4.32        -0.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.83 kN-m.
           -. End Moments (My2) =        2.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.84 kN-m.
          -. End Moments (Mz2) =        4.32 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.84 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         4.364 kN-m.
          -. Mrz        =         4.377 kN-m.
          -. Mr         =         6.181 kN-m.
          -. Pu/Pr      =   0.191  --->  O.K !
          -. Muy/Mry    =   0.191  --->  O.K !
          -. Muz/Mrz    =   0.191  --->  O.K !
          -. Mu/Mr      =   0.191  --->  O.K !
          -. Ratio      =   0.191  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3279.50 kN.
          -. Vuz    =          3.14 kN.
          -. Muy    =         -0.83 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.22 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.25

          -. Vuy    =          6.98 kN.
          -. Muz    =         -0.84 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.13
```

( ). Compute shear strength of concrete.
-. Vuz = 3.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1020.85 kN.
-. phiVcz = phi * Vcz = 918.77 kN.

-. Vuy = 6.98 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 981.34 kN.
-. phiVcy = phi * Vcy = 883.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 634.16 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3943.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 634.16 kN.
-. phiVsz = phi*Vsz = 570.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 627.29 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3982.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 627.29 kN.
-. phiVsy = phi*Vsy = 564.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 7.653 kN.
-. Vr = 1447.768 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 8.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 8.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0053 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0053 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =129035,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3291.08        -0.83         0.00        -0.84         0.00
           ---------------------------------------------------------------------------
            DL+LL+Others     3291.08        -0.83         0.00        -0.84         0.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.192  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.192  --->  O.K !
          -. Ratio      =   0.192  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2167.50 kN.
          -. Vuz    =          3.32 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.66

          -. Vuy    =          1.33 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.55
```

( ). Compute shear strength of concrete.
-. Vuz = 3.32 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1146.77 kN.
-. phiVcz = phi * Vcz = 1032.09 kN.

-. Vuy = 1.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1113.57 kN.
-. phiVcy = phi * Vcy = 1002.21 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 653.46 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3817.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 653.46 kN.
-. phiVsz = phi*Vsz = 588.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 648.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3850.66 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 648.71 kN.
-. phiVsy = phi*Vsy = 583.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 3.579 kN.
-. Vr = 1586.052 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 3.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 3.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139002,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1886.42       542.59       530.00      1662.33      1380.10
           ---------------------------------------------------------------------------
           DL+LL+Others    -1886.42       542.59       530.00      1662.33      1380.10
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2482.344 kN.
          -. Mry        =       717.539 kN-m.
          -. Mrz        =      2180.665 kN-m.
          -. Mr         =      2295.684 kN-m.
          -. Pu/Pr      =   0.760  --->  O.K !
          -. Muy/Mry    =   0.756  --->  O.K !
          -. Muz/Mrz    =   0.762  --->  O.K !
          -. Mu/Mr      =   0.762  --->  O.K !
          -. Ratio      =   0.762  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3106.56 kN.
          -. Vuz    =        256.42 kN.
          -. Muy    =       -496.82 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  35.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.05
```

```
          -. Vuy    =       589.65 kN.
          -. Muz    =     -1701.95 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  36.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   1.92

     ( ). Compute shear strength of concrete.
          -. Vuz       =     256.42 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      644.23 kN.
          -. phiVcz    = phi * Vcz =      579.81 kN.

          -. Vuy       =     589.65 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      601.23 kN.
          -. phiVcy    = phi * Vcy =      541.11 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      543.97 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4319.99 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      543.97 kN.
          -. phiVsz   = phi*Vsz =      489.57 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      528.55 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4363.00 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      528.55 kN.
          -. phiVsy   = phi*Vsy =      475.69 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     642.986 kN.
          -. Vr       =    1016.799 kN.
          -. Ratio    = Vu / Vr = 0.632  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 528.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 543.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0031 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139003,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1878.51       530.00       518.27      1380.10      1114.75
           ---------------------------------------------------------------------------
           DL+LL+Others    -1878.51       530.00       518.27      1380.10      1114.75
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2805.112 kN.
          -. Mry        =       791.185 kN-m.
          -. Mrz        =      2071.074 kN-m.
          -. Mr         =      2217.053 kN-m.
          -. Pu/Pr      =   0.670  --->  O.K !
          -. Muy/Mry    =   0.670  --->  O.K !
          -. Muz/Mrz    =   0.666  --->  O.K !
          -. Mu/Mr      =   0.670  --->  O.K !
          -. Ratio      =   0.670  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3118.55 kN.
          -. Vuz    =        228.38 kN.
          -. Muy    =       -496.24 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  34.68 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.17
```

```
          -. Vuy    =       554.63 kN.
          -. Muz    =     -1411.81 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  35.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.03

     ( ). Compute shear strength of concrete.
          -. Vuz       =     228.38 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      679.38 kN.
          -. phiVcz    = phi * Vcz =      611.44 kN.

          -. Vuy       =     554.63 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      635.76 kN.
          -. phiVcy    = phi * Vcy =      572.19 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      555.50 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4284.85 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      555.50 kN.
          -. phiVsz   = phi*Vsz =      499.95 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      541.05 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4328.46 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      541.05 kN.
          -. phiVsy   = phi*Vsy =      486.95 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     599.808 kN.
          -. Vr       =    1059.133 kN.
          -. Ratio    = Vu / Vr = 0.566  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 541.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 555.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0019 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139004,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1870.60       518.27       506.70      1114.75       867.47
           ---------------------------------------------------------------------------
           DL+LL+Others    -1870.60       518.27       506.70      1114.75       867.47
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3219.469 kN.
          -. Mry        =       903.935 kN-m.
          -. Mrz        =      1918.012 kN-m.
          -. Mr         =      2120.346 kN-m.
          -. Pu/Pr      =   0.581  --->  O.K !
          -. Muy/Mry    =   0.573  --->  O.K !
          -. Muz/Mrz    =   0.581  --->  O.K !
          -. Mu/Mr      =   0.581  --->  O.K !
          -. Ratio      =   0.581  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3130.53 kN.
          -. Vuz    =        200.59 kN.
          -. Muy    =       -495.40 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  34.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =       517.43 kN.
          -. Muz    =     -1139.10 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  34.80 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.14

     ( ). Compute shear strength of concrete.
          -. Vuz       =      200.59 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      715.73 kN.
          -. phiVcz    = phi * Vcz =      644.16 kN.

          -. Vuy       =      517.43 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      671.67 kN.
          -. phiVcy    = phi * Vcy =      604.51 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      566.53 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4248.50 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      566.53 kN.
          -. phiVsz   = phi*Vsz =      509.88 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      553.05 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4292.55 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      553.05 kN.
          -. phiVsy   = phi*Vsy =      497.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     554.946 kN.
          -. Vr       =    1102.249 kN.
          -. Ratio    = Vu / Vr = 0.503  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 553.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 566.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139005,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1862.68       506.70       495.61       867.47       639.40
           ------------------------------------------------------------------------------
            DL+LL+Others    -1862.68       506.70       495.61       867.47       639.40
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3670.204 kN.
          -. Mry        =      1007.779 kN-m.
          -. Mrz        =      1725.885 kN-m.
          -. Mr         =      1998.574 kN-m.
          -. Pu/Pr      =   0.508  --->  O.K !
          -. Muy/Mry    =   0.503  --->  O.K !
          -. Muz/Mrz    =   0.503  --->  O.K !
          -. Mu/Mr      =   0.508  --->  O.K !
          -. Ratio      =   0.508  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3142.50 kN.
          -. Vuz    =        173.39 kN.
          -. Muy    =       -493.61 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.67 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.40
```

```
          -. Vuy    =       478.48 kN.
          -. Muz    =      -885.04 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  34.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.26

     ( ). Compute shear strength of concrete.
          -. Vuz       =     173.39 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      752.47 kN.
          -. phiVcz    = phi * Vcz =      677.22 kN.

          -. Vuy       =     478.48 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      708.18 kN.
          -. phiVcy    = phi * Vcy =      637.36 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      576.86 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4211.76 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      576.86 kN.
          -. phiVsz   = phi*Vsz =      519.18 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      564.31 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4256.05 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      564.31 kN.
          -. phiVsy   = phi*Vsy =      507.88 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     508.923 kN.
          -. Vr       =    1145.237 kN.
          -. Ratio    = Vu / Vr = 0.444  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 564.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 565.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139006,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1286.97       859.74       922.00       532.12       439.11
           ---------------------------------------------------------------------------
           DL+LL+Others    -1286.97       859.74       922.00       532.12       439.11
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2783.551 kN.
          -. Mry        =      2009.412 kN-m.
          -. Mrz        =       956.547 kN-m.
          -. Mr         =      2225.470 kN-m.
          -. Pu/Pr      =   0.462  --->  O.K !
          -. Muy/Mry    =   0.459  --->  O.K !
          -. Muz/Mrz    =   0.459  --->  O.K !
          -. Mu/Mr      =   0.462  --->  O.K !
          -. Ratio      =   0.462  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3154.46 kN.
          -. Vuz    =        147.15 kN.
          -. Muy    =       -491.14 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.25 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51
```

-. Vuy = 438.27 kN.
-. Muz = -650.79 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 33.78 Deg. [Clause 5.8.3.4.2]
-. betay = 2.37

( ). Compute shear strength of concrete.
-. Vuz = 147.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 788.17 kN.
-. phiVcz = phi * Vcz = 709.35 kN.

-. Vuy = 438.27 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 743.85 kN.
-. phiVcy = phi * Vcy = 669.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.245 m.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.245 m.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 586.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 4176.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 586.20 kN.
-. phiVsz = phi*Vsz = 527.58 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 574.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4220.38 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 574.51 kN.
-. phiVsy = phi*Vsy = 517.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 462.309 kN.
-. Vr = 1186.521 kN.
-. Ratio = Vu / Vr = 0.390 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 513.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 513.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0011 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139007,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1287.20       922.00       963.31       439.11       355.24
           ---------------------------------------------------------------------------
           DL+LL+Others    -1287.20       922.00       963.31       439.11       355.24
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2783.551 kN.
          -. Mry        =      2009.412 kN-m.
          -. Mrz        =       956.547 kN-m.
          -. Mr         =      2225.470 kN-m.
          -. Pu/Pr      =   0.462  --->  O.K !
          -. Muy/Mry    =   0.459  --->  O.K !
          -. Muz/Mrz    =   0.459  --->  O.K !
          -. Mu/Mr      =   0.462  --->  O.K !
          -. Ratio      =   0.462  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3166.40 kN.
          -. Vuz    =        122.24 kN.
          -. Muy    =       -489.22 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.61
```

```
          -. Vuy    =       397.32 kN.
          -. Muz    =      -437.77 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.47

     ( ). Compute shear strength of concrete.
          -. Vuz       =      122.24 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      820.37 kN.
          -. phiVcz    = phi * Vcz =      738.33 kN.

          -. Vuy       =      397.32 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      776.20 kN.
          -. phiVcy    = phi * Vcy =      698.58 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      594.08 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4143.86 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      594.08 kN.
          -. phiVsz   = phi*Vsz =      534.67 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      583.14 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4188.03 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      583.14 kN.
          -. phiVsy   = phi*Vsy =      524.83 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     415.699 kN.
          -. Vr       =    1223.406 kN.
          -. Ratio    = Vu / Vr = 0.340  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 461.89 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 461.89 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0018 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139008,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1270.76       963.31       984.76       355.24       302.52
           ------------------------------------------------------------------------------
            DL+LL+Others    -1270.76       963.31       984.76       355.24       302.52
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2758.126 kN.
          -. Mry        =      2137.327 kN-m.
          -. Mrz        =       658.811 kN-m.
          -. Mr         =      2236.559 kN-m.
          -. Pu/Pr      =   0.461  --->  O.K !
          -. Muy/Mry    =   0.461  --->  O.K !
          -. Muz/Mrz    =   0.459  --->  O.K !
          -. Mu/Mr      =   0.461  --->  O.K !
          -. Ratio      =   0.461  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3178.33 kN.
          -. Vuz    =         99.12 kN.
          -. Muy    =       -487.49 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70
```

```
          -. Vuy    =       356.22 kN.
          -. Muz    =      -250.35 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56

     ( ). Compute shear strength of concrete.
          -. Vuz       =      99.12 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      845.58 kN.
          -. phiVcz    = phi * Vcz =      761.02 kN.

          -. Vuy       =     356.22 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      801.64 kN.
          -. phiVcy    = phi * Vcy =      721.48 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      599.93 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4118.64 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      599.93 kN.
          -. phiVsz   = phi*Vsz =      539.94 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      589.55 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4162.59 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      589.55 kN.
          -. phiVsy   = phi*Vsy =      530.60 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     369.754 kN.
          -. Vr       =    1252.077 kN.
          -. Ratio    = Vu / Vr = 0.295  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 410.84 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 410.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139009,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1262.63       984.76       989.02       302.52       312.50
           ---------------------------------------------------------------------------
            DL+LL+Others    -1262.63       984.76       989.02       302.52       312.50
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2711.734 kN.
          -. Mry        =      2144.049 kN-m.
          -. Mrz        =       678.314 kN-m.
          -. Mr         =      2248.790 kN-m.
          -. Pu/Pr      =   0.466  --->  O.K !
          -. Muy/Mry    =   0.461  --->  O.K !
          -. Muz/Mrz    =   0.461  --->  O.K !
          -. Mu/Mr      =   0.466  --->  O.K !
          -. Ratio      =   0.466  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3201.81 kN.
          -. Vuz    =         78.79 kN.
          -. Muy    =       -482.29 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71
```

```
          -. Vuy    =       315.54 kN.
          -. Muz    =      -252.24 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.57

     ( ). Compute shear strength of concrete.
          -. Vuz       =       78.79 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      850.79 kN.
          -. phiVcz    = phi * Vcz =      765.71 kN.

          -. Vuy       =      315.54 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      806.91 kN.
          -. phiVcy    = phi * Vcy =      726.22 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      601.10 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4113.43 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      601.10 kN.
          -. phiVsz   = phi*Vsz =      540.99 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      590.84 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4157.32 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      590.84 kN.
          -. phiVsy   = phi*Vsy =      531.76 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     325.232 kN.
          -. Vr       =    1257.980 kN.
          -. Ratio    = Vu / Vr = 0.259  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 361.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 361.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0024 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139010,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1262.83       989.02       977.42       312.50       328.34
           ---------------------------------------------------------------------------
           DL+LL+Others    -1262.83       989.02       977.42       312.50       328.34
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2711.734 kN.
          -. Mry        =      2144.049 kN-m.
          -. Mrz        =       678.314 kN-m.
          -. Mr         =      2248.790 kN-m.
          -. Pu/Pr      =   0.466  --->  O.K !
          -. Muy/Mry    =   0.461  --->  O.K !
          -. Muz/Mrz    =   0.461  --->  O.K !
          -. Mu/Mr      =   0.466  --->  O.K !
          -. Ratio      =   0.466  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3213.71 kN.
          -. Vuz    =         70.87 kN.
          -. Muy    =       -477.68 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.69
```

```
          -. Vuy    =       275.89 kN.
          -. Muz    =      -361.87 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.55

     ( ). Compute shear strength of concrete.
          -. Vuz       =       70.87 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      845.04 kN.
          -. phiVcz    = phi * Vcz =      760.54 kN.

          -. Vuy       =      275.89 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      801.09 kN.
          -. phiVcy    = phi * Vcy =      720.98 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      599.81 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4119.19 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      599.81 kN.
          -. phiVsz   = phi*Vsz =      539.82 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      589.42 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4163.13 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      589.42 kN.
          -. phiVsy   = phi*Vsy =      530.48 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     284.850 kN.
          -. Vr       =    1251.462 kN.
          -. Ratio    = Vu / Vr = 0.228  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 316.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 316.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139011,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1254.70       977.42       951.40       328.34       341.75
           ---------------------------------------------------------------------------
           DL+LL+Others    -1254.70       977.42       951.40       328.34       341.75
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2726.935 kN.
          -. Mry        =      2130.301 kN-m.
          -. Mrz        =       717.518 kN-m.
          -. Mr         =      2247.891 kN-m.
          -. Pu/Pr      =   0.460  --->  O.K !
          -. Muy/Mry    =   0.459  --->  O.K !
          -. Muz/Mrz    =   0.458  --->  O.K !
          -. Mu/Mr      =   0.460  --->  O.K !
          -. Ratio      =   0.460  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3225.60 kN.
          -. Vuz    =         72.50 kN.
          -. Muy    =       -470.03 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.67
```

```
          -. Vuy    =       237.86 kN.
          -. Muz    =      -458.08 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53

     ( ). Compute shear strength of concrete.
          -. Vuz       =       72.50 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      838.42 kN.
          -. phiVcz    = phi * Vcz =      754.58 kN.

          -. Vuy       =      237.86 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      794.41 kN.
          -. phiVcy    = phi * Vcy =      714.96 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      598.29 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4125.81 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      598.29 kN.
          -. phiVsz   = phi*Vsz =      538.47 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      587.76 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4169.82 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      587.76 kN.
          -. phiVsy   = phi*Vsy =      528.99 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     248.665 kN.
          -. Vr       =    1243.951 kN.
          -. Ratio    = Vu / Vr = 0.200  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 276.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 276.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139012,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1246.55       951.40       913.15       341.75       352.55
           ---------------------------------------------------------------------------
           DL+LL+Others    -1246.55       951.40       913.15       341.75       352.55
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2764.583 kN.
          -. Mry        =      2108.669 kN-m.
          -. Mrz        =       758.757 kN-m.
          -. Mr         =      2241.026 kN-m.
          -. Pu/Pr      =   0.451  --->  O.K !
          -. Muy/Mry    =   0.451  --->  O.K !
          -. Muz/Mrz    =   0.450  --->  O.K !
          -. Mu/Mr      =   0.451  --->  O.K !
          -. Ratio      =   0.451  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3237.48 kN.
          -. Vuz    =         74.02 kN.
          -. Muy    =       -459.02 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.65
```

```
          -. Vuy    =       202.01 kN.
          -. Muz    =      -539.73 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.25 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51

     ( ). Compute shear strength of concrete.
          -. Vuz       =       74.02 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      832.44 kN.
          -. phiVcz    = phi * Vcz =      749.20 kN.

          -. Vuy       =      202.01 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      788.37 kN.
          -. phiVcy    = phi * Vcy =      709.53 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      596.92 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4131.78 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      596.92 kN.
          -. phiVsz   = phi*Vsz =      537.22 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      586.25 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4175.85 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      586.25 kN.
          -. phiVsy   = phi*Vsy =      527.62 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     215.145 kN.
          -. Vr       =    1237.159 kN.
          -. Ratio    = Vu / Vr = 0.174  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 239.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 239.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139013,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1238.40       913.15       855.04       352.55       355.16
           ---------------------------------------------------------------------------
           DL+LL+Others    -1238.40       913.15       855.04       352.55       355.16
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2834.548 kN.
          -. Mry        =      2075.377 kN-m.
          -. Mrz        =       795.523 kN-m.
          -. Mr         =      2222.622 kN-m.
          -. Pu/Pr      =   0.437  --->  O.K !
          -. Muy/Mry    =   0.440  --->  O.K !
          -. Muz/Mrz    =   0.443  --->  O.K !
          -. Mu/Mr      =   0.443  --->  O.K !
          -. Ratio      =   0.443  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2677.38 kN.
          -. Vuz    =        127.89 kN.
          -. Muy    =       -940.02 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62
```

```
          -. Vuy    =         97.45 kN.
          -. Muz    =       -337.11 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48

     ( ). Compute shear strength of concrete.
          -. Vuz       =      127.89 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      823.49 kN.
          -. phiVcz    = phi * Vcz =      741.14 kN.

          -. Vuy       =       97.45 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      779.34 kN.
          -. phiVcy    = phi * Vcy =      701.41 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      594.82 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4140.74 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      594.82 kN.
          -. phiVsz   = phi*Vsz =      535.34 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      583.95 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4184.89 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      583.95 kN.
          -. phiVsy   = phi*Vsy =      525.55 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     160.791 kN.
          -. Vr       =    1226.960 kN.
          -. Ratio    = Vu / Vr = 0.131  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 178.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 178.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139014,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1230.24       855.04       782.09       355.16       350.16
           ---------------------------------------------------------------------------
           DL+LL+Others    -1230.24       855.04       782.09       355.16       350.16
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2931.306 kN.
          -. Mry        =      2031.095 kN-m.
          -. Mrz        =       834.583 kN-m.
          -. Mr         =      2195.877 kN-m.
          -. Pu/Pr      =   0.420  --->  O.K !
          -. Muy/Mry    =   0.421  --->  O.K !
          -. Muz/Mrz    =   0.426  --->  O.K !
          -. Mu/Mr      =   0.426  --->  O.K !
          -. Ratio      =   0.426  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2689.12 kN.
          -. Vuz    =        154.89 kN.
          -. Muy    =       -882.45 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.65
```

```
          -. Vuy    =         73.74 kN.
          -. Muz    =       -338.35 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51

     ( ). Compute shear strength of concrete.
          -. Vuz       =      154.89 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      831.02 kN.
          -. phiVcz    = phi * Vcz =      747.92 kN.

          -. Vuy       =       73.74 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      786.94 kN.
          -. phiVcy    = phi * Vcy =      708.24 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      596.58 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4133.21 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      596.58 kN.
          -. phiVsz   = phi*Vsz =      536.93 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      585.89 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4177.29 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      585.89 kN.
          -. phiVsy   = phi*Vsy =      527.30 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     171.547 kN.
          -. Vr       =    1235.539 kN.
          -. Ratio    = Vu / Vr = 0.139  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 190.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 190.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139015,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1782.70       382.71       348.79       638.06       643.09
           ---------------------------------------------------------------------------
           DL+LL+Others    -1782.70       382.71       348.79       638.06       643.09
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4355.908 kN.
          -. Mry        =       935.838 kN-m.
          -. Mrz        =      1555.723 kN-m.
          -. Mr         =      1815.507 kN-m.
          -. Pu/Pr      =   0.409  --->  O.K !
          -. Muy/Mry    =   0.409  --->  O.K !
          -. Muz/Mrz    =   0.410  --->  O.K !
          -. Mu/Mr      =   0.410  --->  O.K !
          -. Ratio      =   0.410  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2700.85 kN.
          -. Vuz    =        173.18 kN.
          -. Muy    =       -809.01 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.68 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.68
```

```
          -. Vuy    =        53.52 kN.
          -. Muz    =      -332.73 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54

     ( ). Compute shear strength of concrete.
          -. Vuz       =     173.18 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     841.97 kN.
          -. phiVcz    = phi * Vcz =     757.78 kN.

          -. Vuy       =      53.52 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     797.99 kN.
          -. phiVcy    = phi * Vcy =     718.20 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      599.11 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4122.25 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      599.11 kN.
          -. phiVsz   = phi*Vsz =      539.20 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      588.65 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4166.23 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      588.65 kN.
          -. phiVsy   = phi*Vsy =      529.79 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     181.262 kN.
          -. Vr       =    1247.984 kN.
          -. Ratio    = Vu / Vr = 0.145  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 201.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 201.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139016,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1774.63       348.79       311.14       643.09       628.66
           ---------------------------------------------------------------------------
           DL+LL+Others    -1774.63       348.79       311.14       643.09       628.66
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4390.185 kN.
          -. Mry        =       857.714 kN-m.
          -. Mrz        =      1589.776 kN-m.
          -. Mr         =      1806.394 kN-m.
          -. Pu/Pr      =   0.404  --->  O.K !
          -. Muy/Mry    =   0.407  --->  O.K !
          -. Muz/Mrz    =   0.405  --->  O.K !
          -. Mu/Mr      =   0.407  --->  O.K !
          -. Ratio      =   0.407  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2712.57 kN.
          -. Vuz    =        183.21 kN.
          -. Muy    =       -724.73 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73
```

```
          -. Vuy    =        48.65 kN.
          -. Muz    =      -320.82 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.99 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.59

     ( ). Compute shear strength of concrete.
          -. Vuz       =     183.21 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     855.71 kN.
          -. phiVcz    = phi * Vcz =     770.14 kN.

          -. Vuy       =      48.65 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     811.89 kN.
          -. phiVcy    = phi * Vcy =     730.70 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      602.20 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4108.52 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      602.20 kN.
          -. phiVsz   = phi*Vsz =      541.98 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      592.05 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4152.34 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      592.05 kN.
          -. phiVsy   = phi*Vsy =      532.85 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     189.561 kN.
          -. Vr       =    1263.547 kN.
          -. Ratio    = Vu / Vr = 0.150  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 210.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 210.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0010 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139017,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1766.55       311.14       271.67       628.66       598.73
           ---------------------------------------------------------------------------
           DL+LL+Others    -1766.55       311.14       271.67       628.66       598.73
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4501.332 kN.
          -. Mry        =       778.415 kN-m.
          -. Mrz        =      1598.703 kN-m.
          -. Mr         =      1778.140 kN-m.
          -. Pu/Pr      =   0.392  --->  O.K !
          -. Muy/Mry    =   0.400  --->  O.K !
          -. Muz/Mrz    =   0.393  --->  O.K !
          -. Mu/Mr      =   0.400  --->  O.K !
          -. Ratio      =   0.400  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2724.28 kN.
          -. Vuz    =        185.26 kN.
          -. Muy    =       -634.49 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78
```

```
          -. Vuy    =        53.55 kN.
          -. Muz    =      -303.68 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64

     ( ). Compute shear strength of concrete.
          -. Vuz       =     185.26 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     872.02 kN.
          -. phiVcz    = phi * Vcz =      784.82 kN.

          -. Vuy       =      53.55 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     828.43 kN.
          -. phiVcy    = phi * Vcy =      745.59 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      605.78 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4092.20 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      605.78 kN.
          -. phiVsz   = phi*Vsz =      545.20 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      595.98 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4135.79 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      595.98 kN.
          -. phiVsy   = phi*Vsy =      536.38 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     192.847 kN.
          -. Vr       =    1281.972 kN.
          -. Ratio    = Vu / Vr = 0.150  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 214.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 214.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139018,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1758.46       271.67       232.15       598.73       557.18
           ---------------------------------------------------------------------------
           DL+LL+Others    -1758.46       271.67       232.15       598.73       557.18
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4632.865 kN.
          -. Mry        =       706.861 kN-m.
          -. Mrz        =      1593.119 kN-m.
          -. Mr         =      1742.895 kN-m.
          -. Pu/Pr      =   0.380  --->  O.K !
          -. Muy/Mry    =   0.384  --->  O.K !
          -. Muz/Mrz    =   0.376  --->  O.K !
          -. Mu/Mr      =   0.384  --->  O.K !
          -. Ratio      =   0.384  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2735.98 kN.
          -. Vuz    =        180.10 kN.
          -. Muy    =       -542.72 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.22 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84
```

```
          -. Vuy    =        56.94 kN.
          -. Muz    =      -282.49 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.63 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.70

     ( ). Compute shear strength of concrete.
          -. Vuz       =     180.10 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      890.58 kN.
          -. phiVcz    = phi * Vcz =      801.52 kN.

          -. Vuy       =      56.94 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      847.30 kN.
          -. phiVcy    = phi * Vcy =      762.57 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      609.72 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4073.65 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      609.72 kN.
          -. phiVsz   = phi*Vsz =      548.75 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      600.32 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4116.93 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      600.32 kN.
          -. phiVsy   = phi*Vsy =      540.28 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     188.885 kN.
          -. Vr       =    1302.854 kN.
          -. Ratio    = Vu / Vr = 0.145  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 209.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 209.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139019,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1750.35       232.15       194.14       557.18       507.72
           ------------------------------------------------------------------------------
            DL+LL+Others    -1750.35       232.15       194.14       557.18       507.72
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4843.641 kN.
          -. Mry        =       642.009 kN-m.
          -. Mrz        =      1553.418 kN-m.
          -. Mr         =      1680.858 kN-m.
          -. Pu/Pr      =   0.361  --->  O.K !
          -. Muy/Mry    =   0.362  --->  O.K !
          -. Muz/Mrz    =   0.359  --->  O.K !
          -. Mu/Mr      =   0.362  --->  O.K !
          -. Ratio      =   0.362  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2747.68 kN.
          -. Vuz    =        168.76 kN.
          -. Muy    =       -453.26 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90
```

```
          -. Vuy    =        58.49 kN.
          -. Muz    =      -258.46 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.77

     ( ). Compute shear strength of concrete.
          -. Vuz       =     168.76 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      910.60 kN.
          -. phiVcz    = phi * Vcz =      819.54 kN.

          -. Vuy       =      58.49 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      867.72 kN.
          -. phiVcy    = phi * Vcy =      780.95 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      613.83 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4053.62 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      613.83 kN.
          -. phiVsz   = phi*Vsz =      552.45 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      604.85 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4096.50 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      604.85 kN.
          -. phiVsy   = phi*Vsy =      544.36 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     178.604 kN.
          -. Vr       =    1325.312 kN.
          -. Ratio    = Vu / Vr = 0.135  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 198.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 198.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139020,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1742.23       194.14       158.93       507.72       453.77
           ---------------------------------------------------------------------------
           DL+LL+Others    -1742.23       194.14       158.93       507.72       453.77
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5121.560 kN.
          -. Mry        =       570.184 kN-m.
          -. Mrz        =      1492.255 kN-m.
          -. Mr         =      1597.478 kN-m.
          -. Pu/Pr      =   0.340  --->  O.K !
          -. Muy/Mry    =   0.340  --->  O.K !
          -. Muz/Mrz    =   0.340  --->  O.K !
          -. Mu/Mr      =   0.340  --->  O.K !
          -. Ratio      =   0.340  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2759.37 kN.
          -. Vuz    =        152.50 kN.
          -. Muy    =       -369.30 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97
```

```
          -. Vuy    =        58.15 kN.
          -. Muz    =      -232.77 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.24 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.83

     ( ). Compute shear strength of concrete.
          -. Vuz       =     152.50 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      931.29 kN.
          -. phiVcz    = phi * Vcz =      838.16 kN.

          -. Vuy       =      58.15 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      888.89 kN.
          -. phiVcy    = phi * Vcy =      800.00 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      617.94 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4032.94 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      617.94 kN.
          -. phiVsz   = phi*Vsz =      556.14 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      609.37 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4075.34 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      609.37 kN.
          -. phiVsy   = phi*Vsy =      548.43 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     163.206 kN.
          -. Vr       =    1348.430 kN.
          -. Ratio    = Vu / Vr = 0.121  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 181.34 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 181.34 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0025 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139021,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1734.09       158.93       127.55       453.77       398.40
           ------------------------------------------------------------------------------
            DL+LL+Others    -1734.09       158.93       127.55       453.77       398.40
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5418.438 kN.
          -. Mry        =       497.982 kN-m.
          -. Mrz        =      1424.243 kN-m.
          -. Mr         =      1508.793 kN-m.
          -. Pu/Pr      =   0.320  --->  O.K !
          -. Muy/Mry    =   0.319  --->  O.K !
          -. Muz/Mrz    =   0.319  --->  O.K !
          -. Mu/Mr      =   0.320  --->  O.K !
          -. Ratio      =   0.320  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2771.05 kN.
          -. Vuz    =        132.54 kN.
          -. Muy    =       -293.36 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.03
```

```
          -. Vuy    =        56.03 kN.
          -. Muz    =      -206.52 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.90

     ( ). Compute shear strength of concrete.
          -. Vuz       =     132.54 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      951.82 kN.
          -. phiVcz    = phi * Vcz =      856.64 kN.

          -. Vuy       =      56.03 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      909.97 kN.
          -. phiVcy    = phi * Vcy =      818.97 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      621.87 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4012.41 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      621.87 kN.
          -. phiVsz   = phi*Vsz =      559.68 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      613.70 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4054.26 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      613.70 kN.
          -. phiVsy   = phi*Vsy =      552.33 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     143.895 kN.
          -. Vr       =    1371.303 kN.
          -. Ratio    = Vu / Vr = 0.105  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 159.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 159.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139022,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1725.95       127.55       100.72       398.40       344.25
           ------------------------------------------------------------------------------
            DL+LL+Others    -1725.95       127.55       100.72       398.40       344.25
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5776.354 kN.
          -. Mry        =       420.954 kN-m.
          -. Mrz        =      1337.810 kN-m.
          -. Mr         =      1402.475 kN-m.
          -. Pu/Pr      =   0.299  --->  O.K !
          -. Muy/Mry    =   0.303  --->  O.K !
          -. Muz/Mrz    =   0.298  --->  O.K !
          -. Mu/Mr      =   0.303  --->  O.K !
          -. Ratio      =   0.303  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3343.98 kN.
          -. Vuz    =         59.00 kN.
          -. Muy    =       -138.71 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86
```

```
          -. Vuy    =       106.28 kN.
          -. Muz    =      -388.07 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.57 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.72

     ( ). Compute shear strength of concrete.
          -. Vuz       =      59.00 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      896.78 kN.
          -. phiVcz    = phi * Vcz =      807.10 kN.

          -. Vuy       =     106.28 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      853.62 kN.
          -. phiVcy    = phi * Vcy =      768.25 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      611.01 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4067.45 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      611.01 kN.
          -. phiVsz   = phi*Vsz =      549.91 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      601.73 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4110.61 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      601.73 kN.
          -. phiVsy   = phi*Vsy =      541.56 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     121.559 kN.
          -. Vr       =    1309.815 kN.
          -. Ratio    = Vu / Vr = 0.093  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 135.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 135.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139023,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1717.79       100.72        78.16       344.25       293.03
           ---------------------------------------------------------------------------
           DL+LL+Others    -1717.79       100.72        78.16       344.25       293.03
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -6163.516 kN.
          -. Mry        =       352.378 kN-m.
          -. Mrz        =      1235.215 kN-m.
          -. Mr         =      1284.494 kN-m.
          -. Pu/Pr      =   0.279  --->  O.K !
          -. Muy/Mry    =   0.286  --->  O.K !
          -. Muz/Mrz    =   0.279  --->  O.K !
          -. Mu/Mr      =   0.286  --->  O.K !
          -. Ratio      =   0.286  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3355.71 kN.
          -. Vuz    =         49.68 kN.
          -. Muy    =       -109.75 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90
```

```
          -. Vuy    =       100.37 kN.
          -. Muz    =      -335.40 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76

     ( ). Compute shear strength of concrete.
          -. Vuz       =       49.68 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      910.15 kN.
          -. phiVcz    = phi * Vcz =      819.14 kN.

          -. Vuy       =      100.37 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      867.26 kN.
          -. phiVcy    = phi * Vcy =      780.54 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      613.74 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4054.08 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      613.74 kN.
          -. phiVsz   = phi*Vsz =      552.37 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      604.74 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4096.96 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      604.74 kN.
          -. phiVsy   = phi*Vsy =      544.27 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     111.992 kN.
          -. Vr       =    1324.806 kN.
          -. Ratio    = Vu / Vr = 0.085  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 124.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 124.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139024,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1709.62        78.16        59.17       293.03       245.32
           ------------------------------------------------------------------------------
            DL+LL+Others    -1709.62        78.16        59.17       293.03       245.32
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -6556.326 kN.
          -. Mry        =       301.859 kN-m.
          -. Mrz        =      1117.716 kN-m.
          -. Mr         =      1157.760 kN-m.
          -. Pu/Pr      =   0.261  --->  O.K !
          -. Muy/Mry    =   0.259  --->  O.K !
          -. Muz/Mrz    =   0.262  --->  O.K !
          -. Mu/Mr      =   0.262  --->  O.K !
          -. Ratio      =   0.262  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3367.44 kN.
          -. Vuz    =         41.92 kN.
          -. Muy    =        -85.33 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.95 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.94
```

```
          -. Vuy    =         93.40 kN.
          -. Muz    =       -285.55 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.32 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.81

     ( ). Compute shear strength of concrete.
          -. Vuz       =       41.92 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      922.96 kN.
          -. phiVcz    = phi * Vcz =      830.66 kN.

          -. Vuy       =       93.40 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      880.36 kN.
          -. phiVcy    = phi * Vcy =      792.32 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      616.30 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4041.27 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      616.30 kN.
          -. phiVsz   = phi*Vsz =      554.67 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      607.56 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4083.87 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      607.56 kN.
          -. phiVsy   = phi*Vsy =      546.81 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     102.373 kN.
          -. Vr       =    1339.130 kN.
          -. Ratio    = Vu / Vr = 0.076  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 113.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 113.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139025,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1701.43        59.17        43.68       245.32       201.90
           ---------------------------------------------------------------------------
           DL+LL+Others    -1701.43        59.17        43.68       245.32       201.90
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -6938.346 kN.
          -. Mry        =       235.015 kN-m.
          -. Mrz        =      1006.287 kN-m.
          -. Mr         =      1033.366 kN-m.
          -. Pu/Pr      =   0.245  --->  O.K !
          -. Muy/Mry    =   0.252  --->  O.K !
          -. Muz/Mrz    =   0.244  --->  O.K !
          -. Mu/Mr      =   0.252  --->  O.K !
          -. Ratio      =   0.252  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3379.15 kN.
          -. Vuz    =         34.29 kN.
          -. Muy    =        -64.73 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98
```

```
          -. Vuy    =        84.92 kN.
          -. Muz    =      -239.11 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.20 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.85

     ( ). Compute shear strength of concrete.
          -. Vuz       =       34.29 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      935.27 kN.
          -. phiVcz    = phi * Vcz =      841.74 kN.

          -. Vuy       =       84.92 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      892.97 kN.
          -. phiVcy    = phi * Vcy =      803.68 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      618.71 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4028.96 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      618.71 kN.
          -. phiVsz   = phi*Vsz =      556.84 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      610.22 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4071.25 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      610.22 kN.
          -. phiVsy   = phi*Vsy =      549.20 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      91.583 kN.
          -. Vr       =    1352.873 kN.
          -. Ratio    = Vu / Vr = 0.068  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 101.76 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 101.76 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0043 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0043 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139026,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1693.23        43.68        31.50       201.90       163.25
           ---------------------------------------------------------------------------
           DL+LL+Others    -1693.23        43.68        31.50       201.90       163.25
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -7337.566 kN.
          -. Mry        =       196.924 kN-m.
          -. Mrz        =       881.744 kN-m.
          -. Mr         =       903.467 kN-m.
          -. Pu/Pr      =   0.231  --->  O.K !
          -. Muy/Mry    =   0.222  --->  O.K !
          -. Muz/Mrz    =   0.229  --->  O.K !
          -. Mu/Mr      =   0.231  --->  O.K !
          -. Ratio      =   0.231  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3390.84 kN.
          -. Vuz    =         27.03 kN.
          -. Muy    =        -47.89 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.02
```

```
          -. Vuy    =         75.53 kN.
          -. Muz    =       -196.83 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88

     ( ). Compute shear strength of concrete.
          -. Vuz       =       27.03 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      946.79 kN.
          -. phiVcz    = phi * Vcz =      852.11 kN.

          -. Vuy       =       75.53 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      904.79 kN.
          -. phiVcy    = phi * Vcy =      814.31 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      620.92 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4017.44 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      620.92 kN.
          -. phiVsz   = phi*Vsz =      558.83 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      612.65 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4059.43 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      612.65 kN.
          -. phiVsy   = phi*Vsy =      551.39 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      80.219 kN.
          -. Vr       =    1365.703 kN.
          -. Ratio    = Vu / Vr = 0.059  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 89.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 89.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139027,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1685.02        31.50        21.84       163.25       128.70
           ---------------------------------------------------------------------------
           DL+LL+Others    -1685.02        31.50        21.84       163.25       128.70
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -7752.154 kN.
          -. Mry        =       141.969 kN-m.
          -. Mrz        =       749.397 kN-m.
          -. Mr         =       762.726 kN-m.
          -. Pu/Pr      =   0.217  --->  O.K !
          -. Muy/Mry    =   0.222  --->  O.K !
          -. Muz/Mrz    =   0.218  --->  O.K !
          -. Mu/Mr      =   0.222  --->  O.K !
          -. Ratio      =   0.222  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3402.52 kN.
          -. Vuz    =         21.54 kN.
          -. Muy    =        -34.62 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.68 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.05
```

```
          -. Vuy    =         67.51 kN.
          -. Muz    =       -159.19 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92

     ( ). Compute shear strength of concrete.
          -. Vuz       =       21.54 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      956.91 kN.
          -. phiVcz    = phi * Vcz =      861.22 kN.

          -. Vuy       =       67.51 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      915.20 kN.
          -. phiVcy    = phi * Vcy =      823.68 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      622.82 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4007.32 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      622.82 kN.
          -. phiVsz   = phi*Vsz =      560.54 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      614.76 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4049.03 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      614.76 kN.
          -. phiVsy   = phi*Vsy =      553.28 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      70.862 kN.
          -. Vr       =    1376.963 kN.
          -. Ratio    = Vu / Vr = 0.051  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 78.74 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 78.74 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0047 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139028,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1676.80        21.84        14.03       128.70        97.30
           ---------------------------------------------------------------------------
           DL+LL+Others    -1676.80        21.84        14.03       128.70        97.30
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -8132.478 kN.
          -. Mry        =       105.508 kN-m.
          -. Mrz        =       619.404 kN-m.
          -. Mr         =       628.325 kN-m.
          -. Pu/Pr      =   0.206  --->  O.K !
          -. Muy/Mry    =   0.207  --->  O.K !
          -. Muz/Mrz    =   0.208  --->  O.K !
          -. Mu/Mr      =   0.208  --->  O.K !
          -. Ratio      =   0.208  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3414.20 kN.
          -. Vuz    =         17.76 kN.
          -. Muy    =        -24.07 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.61 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.08
```

```
          -. Vuy    =         61.35 kN.
          -. Muz    =       -125.52 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95

     ( ). Compute shear strength of concrete.
          -. Vuz       =       17.76 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      965.70 kN.
          -. phiVcz    = phi * Vcz =      869.13 kN.

          -. Vuy       =       61.35 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      924.26 kN.
          -. phiVcy    = phi * Vcy =      831.83 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      624.45 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3998.52 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      624.45 kN.
          -. phiVsz   = phi*Vsz =      562.01 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      616.56 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4039.97 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      616.56 kN.
          -. phiVsy   = phi*Vsy =      554.90 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      63.868 kN.
          -. Vr       =    1386.732 kN.
          -. Ratio    = Vu / Vr = 0.046  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 70.96 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 70.96 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0049 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0049 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0049 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139029,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1668.56        14.03         9.33        97.30        68.90
           ---------------------------------------------------------------------------
           DL+LL+Others    -1668.56        14.03         9.33        97.30        68.90
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -8496.296 kN.
          -. Mry        =        69.847 kN-m.
          -. Mrz        =       495.123 kN-m.
          -. Mr         =       500.025 kN-m.
          -. Pu/Pr      =   0.196  --->  O.K !
          -. Muy/Mry    =   0.201  --->  O.K !
          -. Muz/Mrz    =   0.197  --->  O.K !
          -. Mu/Mr      =   0.201  --->  O.K !
          -. Ratio      =   0.201  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3425.85 kN.
          -. Vuz    =         14.53 kN.
          -. Muy    =        -15.50 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.10
```

```
          -. Vuy    =         55.51 kN.
          -. Muz    =        -94.92 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.87 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.97

     ( ). Compute shear strength of concrete.
          -. Vuz       =       14.53 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      973.69 kN.
          -. phiVcz    = phi * Vcz =      876.33 kN.

          -. Vuy       =       55.51 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      932.50 kN.
          -. phiVcy    = phi * Vcy =      839.25 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      625.91 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3990.53 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      625.91 kN.
          -. phiVsz   = phi*Vsz =      563.32 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      618.17 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4031.73 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      618.17 kN.
          -. phiVsy   = phi*Vsy =      556.35 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =      57.385 kN.
          -. Vr       =    1395.603 kN.
          -. Ratio    = Vu / Vr = 0.041  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 63.76 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 63.76 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0050 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139030,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3449.06       -10.17        -8.10       -67.24       -42.25
           ------------------------------------------------------------------------------
            DL+LL+Others     3449.06       -10.17        -8.10       -67.24       -42.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.10 kN-m.
           -. End Moments (My2) =       10.17 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.10 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.10 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       42.25 kN-m.
          -. End Moments (Mz2) =       67.24 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -42.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -42.25 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        39.899 kN-m.
          -. Mrz        =       210.330 kN-m.
          -. Mr         =       214.081 kN-m.
          -. Pu/Pr      =   0.201  --->  O.K !
          -. Muy/Mry    =   0.203  --->  O.K !
          -. Muz/Mrz    =   0.201  --->  O.K !
          -. Mu/Mr      =   0.203  --->  O.K !
          -. Ratio      =   0.203  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3437.50 kN.
          -. Vuz    =         11.90 kN.
          -. Muy    =        -10.17 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.13

          -. Vuy    =         50.16 kN.
          -. Muz    =        -67.24 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.81 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.00
```

( ). Compute shear strength of concrete.
-. Vuz = 11.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 980.82 kN.
-. phiVcz = phi * Vcz = 882.74 kN.

-. Vuy = 50.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 939.86 kN.
-. phiVcy = phi * Vcy = 845.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 627.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3983.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 627.20 kN.
-. phiVsz = phi*Vsz = 564.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 619.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4024.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 619.59 kN.
-. phiVsy = phi*Vsy = 557.63 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 51.556 kN.
-. Vr = 1403.504 kN.
-. Ratio = Vu / Vr = 0.037 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 57.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 57.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0052 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139031,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3449.13        -8.10        -6.17       -42.25       -24.14
           ------------------------------------------------------------------------------
            DL+LL+Others     3449.13        -8.10        -6.17       -42.25       -24.14
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        6.17 kN-m.
           -. End Moments (My2) =        8.10 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.10 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.10 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       24.14 kN-m.
          -. End Moments (Mz2) =       42.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -42.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -42.25 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0333
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     17164.865 kN.
           -. Pr         =     17164.865 kN.
           -. Mry        =        39.899 kN-m.
           -. Mrz        =       210.326 kN-m.
           -. Mr         =       214.077 kN-m.
           -. Pu/Pr      =   0.201  --->  O.K !
           -. Muy/Mry    =   0.203  --->  O.K !
           -. Muz/Mrz    =   0.201  --->  O.K !
           -. Mu/Mr      =   0.203  --->  O.K !
           -. Ratio      =   0.203  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0003 m^2.
           -. Pu     =       3449.13 kN.
           -. Vuz    =          6.09 kN.
           -. Muy    =         -8.10 kN-m.
           -. bvz    =   1.00 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
           -. thetaz =  31.44 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.15

           -. Vuy    =         36.32 kN.
           -. Muz    =        -42.25 kN-m.
           -. bvy    =   1.00 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
           -. thetay =  31.75 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.02
```

( ). Compute shear strength of concrete.
-. Vuz = 6.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 988.89 kN.
-. phiVcz = phi * Vcz = 890.00 kN.

-. Vuy = 36.32 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 948.19 kN.
-. phiVcy = phi * Vcy = 853.37 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 628.64 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3975.34 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 628.64 kN.
-. phiVsz = phi*Vsz = 565.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 621.18 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4016.03 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 621.18 kN.
-. phiVsy = phi*Vsy = 559.07 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 36.827 kN.
-. Vr = 1412.439 kN.
-. Ratio = Vu / Vr = 0.026 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 40.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 40.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0053 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0053 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139032,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3472.31        -6.17        -4.26       -24.14       -11.90
           ------------------------------------------------------------------------------
            DL+LL+Others     3472.31        -6.17        -4.26       -24.14       -11.90
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.26 kN-m.
           -. End Moments (My2) =        6.17 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       11.90 kN-m.
          -. End Moments (Mz2) =       24.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -11.90 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -11.90 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        21.060 kN-m.
          -. Mrz        =        58.846 kN-m.
          -. Mr         =        62.500 kN-m.
          -. Pu/Pr      =   0.202  --->  O.K !
          -. Muy/Mry    =   0.202  --->  O.K !
          -. Muz/Mrz    =   0.202  --->  O.K !
          -. Mu/Mr      =   0.202  --->  O.K !
          -. Ratio      =   0.202  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3460.75 kN.
          -. Vuz    =          4.33 kN.
          -. Muy    =         -6.17 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.17

          -. Vuy    =         24.52 kN.
          -. Muz    =        -24.14 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.04
```

( ). Compute shear strength of concrete.
-. Vuz = 4.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 994.75 kN.
-. phiVcz = phi * Vcz = 895.27 kN.

-. Vuy = 24.52 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 954.26 kN.
-. phiVcy = phi * Vcy = 858.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 629.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3969.48 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 629.67 kN.
-. phiVsz = phi*Vsz = 566.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 622.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4009.97 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 622.33 kN.
-. phiVsy = phi*Vsy = 560.09 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 24.900 kN.
-. Vr = 1418.928 kN.
-. Ratio = Vu / Vr = 0.018 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 27.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 27.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0054 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0054 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0054 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139033,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3483.92        -4.26        -2.36       -11.90        -4.50
           ------------------------------------------------------------------------------
            DL+LL+Others     3483.92        -4.26        -2.36       -11.90        -4.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.36 kN-m.
           -. End Moments (My2) =        4.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.36 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.36 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.50 kN-m.
          -. End Moments (Mz2) =       11.90 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0333
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     17164.865 kN.
           -. Pr         =     17164.865 kN.
           -. Mry        =        11.645 kN-m.
           -. Mrz        =        22.150 kN-m.
           -. Mr         =        25.024 kN-m.
           -. Pu/Pr      =   0.203  --->  O.K !
           -. Muy/Mry    =   0.203  --->  O.K !
           -. Muz/Mrz    =   0.203  --->  O.K !
           -. Mu/Mr      =   0.203  --->  O.K !
           -. Ratio      =   0.203  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0003 m^2.
           -. Pu     =       3483.92 kN.
           -. Vuz    =          3.97 kN.
           -. Muy    =         -2.36 kN-m.
           -. bvz    =   1.00 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
           -. thetaz =  31.38 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.18

           -. Vuy    =         14.83 kN.
           -. Muz    =         -4.50 kN-m.
           -. bvy    =   1.00 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
           -. thetay =  31.67 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.05
```

( ). Compute shear strength of concrete.
-. Vuz = 3.97 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 998.01 kN.
-. phiVcz = phi * Vcz = 898.21 kN.

-. Vuy = 14.83 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 957.63 kN.
-. phiVcy = phi * Vcy = 861.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 630.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3966.22 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 630.24 kN.
-. phiVsz = phi*Vsz = 567.22 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 622.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4006.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 622.96 kN.
-. phiVsy = phi*Vsy = 560.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 15.355 kN.
-. Vr = 1422.531 kN.
-. Ratio = Vu / Vr = 0.011 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.06 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.06 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0056 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0056 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139034,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3495.51        -2.36        -0.76        -4.50        -0.87
           ------------------------------------------------------------------------------
            DL+LL+Others     3495.51        -2.36        -0.76        -4.50        -0.87
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.76 kN-m.
           -. End Moments (My2) =        2.36 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.76 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.76 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.87 kN-m.
          -. End Moments (Mz2) =        4.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.87 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         3.751 kN-m.
          -. Mrz        =         4.288 kN-m.
          -. Mr         =         5.697 kN-m.
          -. Pu/Pr      =   0.204  --->  O.K !
          -. Muy/Mry    =   0.204  --->  O.K !
          -. Muz/Mrz    =   0.204  --->  O.K !
          -. Mu/Mr      =   0.204  --->  O.K !
          -. Ratio      =   0.204  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       3495.51 kN.
          -. Vuz    =          3.22 kN.
          -. Muy    =         -0.76 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.36 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.19

          -. Vuy    =          7.25 kN.
          -. Muz    =         -0.87 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.06
```

( ). Compute shear strength of concrete.
-. Vuz = 3.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 999.73 kN.
-. phiVcz = phi * Vcz = 899.75 kN.

-. Vuy = 7.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 959.41 kN.
-. phiVcy = phi * Vcy = 863.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 630.54 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3964.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 630.54 kN.
-. phiVsz = phi*Vsz = 567.49 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 623.29 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4004.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 623.29 kN.
-. phiVsy = phi*Vsy = 560.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 7.938 kN.
-. Vr = 1424.432 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 8.82 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 8.82 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0056 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0056 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =139035,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3507.09        -0.76         0.00        -0.87         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3507.09        -0.76         0.00        -0.87         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.76 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.204  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.204  --->  O.K !
          -. Ratio      =   0.204  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2945.36 kN.
          -. Vuz    =          3.28 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.37

          -. Vuy    =          1.35 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 3.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1056.91 kN.
-. phiVcz = phi * Vcz = 951.22 kN.

-. Vuy = 1.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1018.93 kN.
-. phiVcy = phi * Vcy = 917.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 640.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3907.32 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 640.06 kN.
-. phiVsz = phi*Vsz = 576.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 633.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3945.30 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 633.84 kN.
-. phiVsy = phi*Vsy = 570.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 3.550 kN.
-. Vr = 1487.489 kN.
-. Ratio = Vu / Vr = 0.002 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 3.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 3.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0047 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

10.2.CALZADA PEATONAL TRAMO 2

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-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
===========================================================================================


       +============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
       |  MIDAS/Civil - Design & checking system for windows        |
       +============================================================+
       |  RC-Member(Beam or Column) Analysis and Design             |
       |  Based On  AASHTO-LRFD16, AASHTO-LRFD12, AASHTO-LRFD07,    |
       |            AASHTO-LRFD02, AASHTO-LFD96, ACI318-02,         |
       |            CSA-S6-00, CSA-S6-14, Eurocode2-2:05,           |
       |            SNiP 2.05.03-84*, SP 35.13330.2011,             |
       |            SNiP 2.05.03-84*(MKS), SP 35.13330.2011(MKS),   |
       |            IRC:21-2000, IRC:112-2011                       |
       |                                                            |
       |                                          (c)SINCE 1989  |
       +============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)  |
       |  MIDAS IT Design Development Team                          |
       +============================================================+
       |            HomePage : www.MidasUser.com                    |
       +============================================================+
       |  MIDAS/Civil  Version 8.8.5                                |
       +============================================================+


    *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
-------------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
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     65+  1       PL01d-ext_( 4.300) +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300)
            +    PL01i-int_( 4.300) +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300)
            +    PL02d-int_( 4.300) +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300)
            +    PL03i-ext_( 4.300) +    PL03d-int_( 4.300) +    PL03i-int_( 4.300)
            +    PL04d-ext_( 4.300) +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300)
            +    PL04i-int_( 4.300) +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300)
            +    PL05d-int_( 4.300) +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300)
            +    PL06i-ext_( 4.300) +    PL06d-int_( 4.300) +    PL06i-int_( 4.300)
            +    PL07d-ext_( 4.300) +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300)
            +    PL07i-int_( 4.300) +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300)
            +    PL08d-int_( 4.300) +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300)
            +    PL09i-ext_( 4.300) +    PL09d-int_( 4.300) +    PL09i-int_( 4.300)
            +    PL10d-ext_( 4.300) +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300)
            +    PL10i-int_( 4.300)
     65-  1       PL01d-ext_( 4.300) +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300)
            +    PL01i-int_( 4.300) +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300)
            +    PL02d-int_( 4.300) +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300)
            +    PL03i-ext_( 4.300) +    PL03d-int_( 4.300) +    PL03i-int_( 4.300)
            +    PL04d-ext_( 4.300) +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300)
            +    PL04i-int_( 4.300) +    PL05d-ext_( 4.300) +    PL05i-ext_( 4.300)
            +    PL05d-int_( 4.300) +    PL05i-int_( 4.300) +    PL06d-ext_( 4.300)
            +    PL06i-ext_( 4.300) +    PL06d-int_( 4.300) +    PL06i-int_( 4.300)
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            +    PL07i-int_( 4.300) +    PL08d-ext_( 4.300) +    PL08i-ext_( 4.300)
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            +    PL09i-ext_( 4.300) +    PL09d-int_( 4.300) +    PL09i-int_( 4.300)
            +    PL10d-ext_( 4.300) +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300)
            +    PL10i-int_( 4.300)
    66+  1       PL01d-ext_( 7.190) +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190)
            +    PL01i-int_( 7.190) +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190)
            +    PL02d-int_( 7.190) +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190)
            +    PL03i-ext_( 7.190) +    PL03d-int_( 7.190) +    PL03i-int_( 7.190)
            +    PL04d-ext_( 7.190) +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190)
            +    PL04i-int_( 7.190) +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190)
            +    PL05d-int_( 7.190) +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190)
            +    PL06i-ext_( 7.190) +    PL06d-int_( 7.190) +    PL06i-int_( 7.190)
            +    PL07d-ext_( 7.190) +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190)
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            +    PL10i-int_( 7.190)
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            +    PL10i-int_( 7.190)
   148+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.525)
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            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
            +        SE06a_( 1.000) +        SE06b_( 1.000) +        SE07a_( 1.000)
            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
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            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   148-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.525)
            +    PL01i-ext_( 7.525) +    PL01d-int_( 7.525) +    PL01i-int_( 7.525)
            +    PL02d-ext_( 7.525) +    PL02i-ext_( 7.525) +    PL02d-int_( 7.525)
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            +    PL05d-ext_( 7.525) +    PL05i-ext_( 7.525) +    PL05d-int_( 7.525)
            +    PL05i-int_( 7.525) +    PL06d-ext_( 7.525) +    PL06i-ext_( 7.525)
            +    PL06d-int_( 7.525) +    PL06i-int_( 7.525) +    PL07d-ext_( 7.525)
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            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
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            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
            +        SE09a_( 1.000) +        SE09b_( 1.000) +        SE10a_( 1.000)
            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   149+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 1.400) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
            +        SE03a_( 1.000) +        SE03b_( 1.000) +        SE04a_( 1.000)
            +        SE04b_( 1.000) +        SE05a_( 1.000) +        SE05b_( 1.000)
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            +        SE07b_( 1.000) +        SE08a_( 1.000) +        SE08b_( 1.000)
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            +        SE10b_( 1.000) +        SE11a_( 1.000) +        SE11b_( 1.000)
   149-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +        TU_ENV( 1.200)
            +        WS_ENV( 1.400) +        TG_ENV( 0.500) +        SE01a_( 1.000)
            +        SE01b_( 1.000) +        SE02a_( 1.000) +        SE02b_( 1.000)
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   151+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
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            +    PL09d-int_( 4.300) +    PL09i-int_( 4.300) +    PL10d-ext_( 4.300)
            +    PL10i-ext_( 4.300) +    PL10d-int_( 4.300) +    PL10i-int_( 4.300)
            +EQ_0.3X/1.0Y_ENV( 1.000)
    152-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 4.300)
            +    PL01i-ext_( 4.300) +    PL01d-int_( 4.300) +    PL01i-int_( 4.300)
            +    PL02d-ext_( 4.300) +    PL02i-ext_( 4.300) +    PL02d-int_( 4.300)
            +    PL02i-int_( 4.300) +    PL03d-ext_( 4.300) +    PL03i-ext_( 4.300)
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            +    PL04i-ext_( 4.300) +    PL04d-int_( 4.300) +    PL04i-int_( 4.300)
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            +    PL06d-int_( 4.300) +    PL06i-int_( 4.300) +    PL07d-ext_( 4.300)
            +    PL07i-ext_( 4.300) +    PL07d-int_( 4.300) +    PL07i-int_( 4.300)
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            +    PL08i-int_( 4.300) +    PL09d-ext_( 4.300) +    PL09i-ext_( 4.300)
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            +EQ_0.3X/1.0Y_ENV( 1.000)
    153+  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
```

```
            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-ext_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
   153-  1     DC_0.90/1.25( 1.000) +  DW_0.65/1.50( 1.000) +    PL01d-ext_( 7.190)
            +    PL01i-ext_( 7.190) +    PL01d-int_( 7.190) +    PL01i-int_( 7.190)
            +    PL02d-ext_( 7.190) +    PL02i-ext_( 7.190) +    PL02d-int_( 7.190)
            +    PL02i-int_( 7.190) +    PL03d-ext_( 7.190) +    PL03i-ext_( 7.190)
            +    PL03d-int_( 7.190) +    PL03i-int_( 7.190) +    PL04d-ext_( 7.190)
            +    PL04i-ext_( 7.190) +    PL04d-int_( 7.190) +    PL04i-int_( 7.190)
            +    PL05d-ext_( 7.190) +    PL05i-ext_( 7.190) +    PL05d-int_( 7.190)
            +    PL05i-int_( 7.190) +    PL06d-ext_( 7.190) +    PL06i-ext_( 7.190)
            +    PL06d-int_( 7.190) +    PL06i-int_( 7.190) +    PL07d-ext_( 7.190)
            +    PL07i-ext_( 7.190) +    PL07d-int_( 7.190) +    PL07i-int_( 7.190)
            +    PL08d-ext_( 7.190) +    PL08i-ext_( 7.190) +    PL08d-int_( 7.190)
            +    PL08i-int_( 7.190) +    PL09d-ext_( 7.190) +    PL09i-ext_( 7.190)
            +    PL09d-int_( 7.190) +    PL09i-ext_( 7.190) +    PL10d-ext_( 7.190)
            +    PL10i-ext_( 7.190) +    PL10d-int_( 7.190) +    PL10i-int_( 7.190)
```

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112102,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            122.96      3657.66      2751.55       510.51       458.53
           ------------------------------------------------------------------------------
            DL+LL+Others      122.96      3657.66      2751.55       510.51       458.53
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2751.55 kN-m.
           -. End Moments (My2) =     3657.66 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     3657.66 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     3657.66 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      458.53 kN-m.
          -. End Moments (Mz2) =      510.51 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      510.51 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      510.51 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       164.854 kN.
          -. Mry        =      4914.294 kN-m.
          -. Mrz        =       689.790 kN-m.
          -. Mr         =      4962.469 kN-m.
          -. Pu/Pr      =   0.746  --->  O.K !
          -. Muy/Mry    =   0.744  --->  O.K !
          -. Muz/Mrz    =   0.740  --->  O.K !
          -. Mu/Mr      =   0.746  --->  O.K !
          -. Ratio      =   0.746  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2022.93 kN.
          -. Vuz    =       1741.20 kN.
          -. Muy    =      -3344.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  35.30 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.04

          -. Vuy    =        382.40 kN.
          -. Muz    =       -871.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   1.95
```

( ). Compute shear strength of concrete.
-. Vuz = 1741.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 922.58 kN.
-. phiVcz = phi * Vcz = 830.32 kN.

-. Vuy = 382.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 880.42 kN.
-. phiVcy = phi * Vcy = 792.38 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1910.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6225.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1910.49 kN.
-. phiVsz = phi*Vsz = 1719.44 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1873.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6268.06 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1873.83 kN.
-. phiVsy = phi*Vsy = 1686.44 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1782.697 kN.
-. Vr = 2478.824 kN.
-. Ratio = Vu / Vr = 0.719 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1873.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1910.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0110 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0110 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0110 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112103,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            134.88      2751.55      1915.06       458.53       428.86
           ------------------------------------------------------------------------------
            DL+LL+Others      134.88      2751.55      1915.06       458.53       428.86
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1915.06 kN-m.
           -. End Moments (My2) =     2751.55 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2751.55 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2751.55 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      428.86 kN-m.
          -. End Moments (Mz2) =      458.53 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      458.53 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      458.53 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       242.569 kN.
          -. Mry        =      4910.553 kN-m.
          -. Mrz        =       818.579 kN-m.
          -. Mr         =      4978.313 kN-m.
          -. Pu/Pr      =   0.556  --->  O.K !
          -. Muy/Mry    =   0.560  --->  O.K !
          -. Muz/Mrz    =   0.560  --->  O.K !
          -. Mu/Mr      =   0.560  --->  O.K !
          -. Ratio      =   0.560  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2039.66 kN.
          -. Vuz    =       1604.77 kN.
          -. Muy    =      -2474.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.25 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.26

          -. Vuy    =        348.43 kN.
          -. Muz    =       -772.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.16
```

( ). Compute shear strength of concrete.
-. Vuz = 1604.77 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1020.26 kN.
-. phiVcz = phi * Vcz = 918.23 kN.

-. Vuy = 348.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 977.14 kN.
-. phiVcy = phi * Vcy = 879.42 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1986.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6128.23 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1986.72 kN.
-. phiVsz = phi*Vsz = 1788.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1954.46 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6171.35 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1954.46 kN.
-. phiVsy = phi*Vsy = 1759.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1642.160 kN.
-. Vr = 2638.434 kN.
-. Ratio = Vu / Vr = 0.622 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1824.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1824.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0080 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0080 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0080 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112104,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            146.81      1915.06      1150.77       428.86       425.85
           ------------------------------------------------------------------------------
            DL+LL+Others      146.81      1915.06      1150.77       428.86       425.85
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1150.77 kN-m.
           -. End Moments (My2) =     1915.06 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1915.06 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1915.06 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      425.85 kN-m.
          -. End Moments (Mz2) =      428.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      428.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      428.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       370.997 kN.
          -. Mry        =      4882.509 kN-m.
          -. Mrz        =      1098.430 kN-m.
          -. Mr         =      5004.542 kN-m.
          -. Pu/Pr      =   0.396  --->  O.K !
          -. Muy/Mry    =   0.392  --->  O.K !
          -. Muz/Mrz    =   0.390  --->  O.K !
          -. Mu/Mr      =   0.396  --->  O.K !
          -. Ratio      =   0.396  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2056.38 kN.
          -. Vuz    =       1464.44 kN.
          -. Muy    =      -1672.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.50

          -. Vuy    =        314.40 kN.
          -. Muz    =       -698.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.65 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41
```

( ). Compute shear strength of concrete.
-. Vuz = 1464.44 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1129.96 kN.
-. phiVcz = phi * Vcz = 1016.97 kN.

-. Vuy = 314.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1086.60 kN.
-. phiVcy = phi * Vcy = 977.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2060.32 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6018.52 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2060.32 kN.
-. phiVsz = phi*Vsz = 1854.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2032.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6061.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2032.57 kN.
-. phiVsy = phi*Vsy = 1829.31 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1497.814 kN.
-. Vr = 2807.248 kN.
-. Ratio = Vu / Vr = 0.534 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1664.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1664.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0054 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0054 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112105,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            158.73      1150.77       462.72       425.85       463.52
           ------------------------------------------------------------------------------
            DL+LL+Others      158.73      1150.77       462.72       425.85       463.52
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      462.72 kN-m.
           -. End Moments (My2) =     1150.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1150.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1150.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      425.85 kN-m.
          -. End Moments (Mz2) =      463.52 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      425.85 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      425.85 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       657.111 kN.
          -. Mry        =      4715.173 kN-m.
          -. Mrz        =      1752.208 kN-m.
          -. Mr         =      5030.218 kN-m.
          -. Pu/Pr      =   0.242  --->  O.K !
          -. Muy/Mry    =   0.244  --->  O.K !
          -. Muz/Mrz    =   0.243  --->  O.K !
          -. Mu/Mr      =   0.244  --->  O.K !
          -. Ratio      =   0.244  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2089.76 kN.
          -. Vuz    =       1321.69 kN.
          -. Muy    =       -285.90 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =        280.67 kN.
          -. Muz    =       -651.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.66
```

( ). Compute shear strength of concrete.
-. Vuz = 1321.69 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1242.85 kN.
-. phiVcz = phi * Vcz = 1118.56 kN.

-. Vuy = 280.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1200.16 kN.
-. phiVcy = phi * Vcy = 1080.14 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2125.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5905.64 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2125.49 kN.
-. phiVsz = phi*Vsz = 1912.94 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2101.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5948.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2101.96 kN.
-. phiVsy = phi*Vsy = 1891.76 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1351.164 kN.
-. Vr = 2971.900 kN.
-. Ratio = Vu / Vr = 0.455 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1501.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1501.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112106,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2106.48      -285.90      -275.26      -651.05      -671.50
           ------------------------------------------------------------------------------
            DL+LL+Others     2106.48      -285.90      -275.26      -651.05      -671.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      275.26 kN-m.
           -. End Moments (My2) =      285.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -275.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -275.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      651.05 kN-m.
          -. End Moments (Mz2) =      671.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -671.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -671.50 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     13131.093 kN.
          -. Mry        =      1720.049 kN-m.
          -. Mrz        =      4181.213 kN-m.
          -. Mr         =      4521.185 kN-m.
          -. Pu/Pr      =   0.160  --->  O.K !
          -. Muy/Mry    =   0.160  --->  O.K !
          -. Muz/Mrz    =   0.161  --->  O.K !
          -. Mu/Mr      =   0.161  --->  O.K !
          -. Ratio      =   0.161  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2106.48 kN.
          -. Vuz    =       1178.10 kN.
          -. Muy    =       -275.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        247.75 kN.
          -. Muz    =       -671.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 1178.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1284.74 kN.
-. phiVcz = phi * Vcz = 1156.27 kN.

-. Vuy = 247.75 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1242.54 kN.
-. phiVcy = phi * Vcy = 1118.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2147.39 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5863.74 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2147.39 kN.
-. phiVsz = phi*Vsz = 1932.65 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2125.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5905.95 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2125.32 kN.
-. phiVsy = phi*Vsy = 1912.79 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1203.868 kN.
-. Vr = 3031.079 kN.
-. Ratio = Vu / Vr = 0.397 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1337.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1337.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112107,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2123.19      -275.26      -794.81      -671.50      -692.41
           ------------------------------------------------------------------------------
            DL+LL+Others     2123.19      -275.26      -794.81      -671.50      -692.41
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      275.26 kN-m.
           -. End Moments (My2) =      794.81 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -794.81 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -794.81 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      671.50 kN-m.
          -. End Moments (Mz2) =      692.41 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -692.41 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -692.41 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9834.131 kN.
          -. Mry        =      3658.880 kN-m.
          -. Mrz        =      3181.902 kN-m.
          -. Mr         =      4848.907 kN-m.
          -. Pu/Pr      =   0.216  --->  O.K !
          -. Muy/Mry    =   0.217  --->  O.K !
          -. Muz/Mrz    =   0.218  --->  O.K !
          -. Mu/Mr      =   0.218  --->  O.K !
          -. Ratio      =   0.218  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2123.19 kN.
          -. Vuz    =       1035.26 kN.
          -. Muy    =       -794.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89

          -. Vuy    =        216.24 kN.
          -. Muz    =       -692.41 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.36 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.79
```

( ). Compute shear strength of concrete.
-. Vuz = 1035.26 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1303.43 kN.
-. phiVcz = phi * Vcz = 1173.08 kN.

-. Vuy = 216.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1261.49 kN.
-. phiVcy = phi * Vcy = 1135.34 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2156.81 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5845.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2156.81 kN.
-. phiVsz = phi*Vsz = 1941.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2135.38 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5887.00 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2135.38 kN.
-. phiVsy = phi*Vsy = 1921.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1057.606 kN.
-. Vr = 3057.178 kN.
-. Ratio = Vu / Vr = 0.346 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1175.12 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1175.12 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112108,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            206.52       912.39      1338.21       577.82       627.39
           ---------------------------------------------------------------------------
            DL+LL+Others      206.52       912.39      1338.21       577.82       627.39
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      912.39 kN-m.
           -. End Moments (My2) =     1338.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1338.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1338.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      577.82 kN-m.
          -. End Moments (Mz2) =      627.39 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      627.39 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      627.39 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       705.054 kN.
          -. Mry        =      4559.132 kN-m.
          -. Mrz        =      2135.495 kN-m.
          -. Mr         =      5034.484 kN-m.
          -. Pu/Pr      =   0.293  --->  O.K !
          -. Muy/Mry    =   0.294  --->  O.K !
          -. Muz/Mrz    =   0.294  --->  O.K !
          -. Mu/Mr      =   0.294  --->  O.K !
          -. Ratio      =   0.294  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2139.91 kN.
          -. Vuz    =        894.85 kN.
          -. Muy    =      -1247.54 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        186.88 kN.
          -. Muz    =       -709.41 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69
```

( ). Compute shear strength of concrete.
-. Vuz = 894.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1257.47 kN.
-. phiVcz = phi * Vcz = 1131.72 kN.

-. Vuy = 186.88 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1214.93 kN.
-. phiVcy = phi * Vcy = 1093.44 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2133.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5891.02 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2133.26 kN.
-. phiVsz = phi*Vsz = 1919.94 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2110.25 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5933.55 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2110.25 kN.
-. phiVsy = phi*Vsy = 1899.22 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 914.156 kN.
-. Vr = 2992.660 kN.
-. Ratio = Vu / Vr = 0.305 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1015.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1015.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112109,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            218.46      1338.21      1698.61       627.39       666.13
           ------------------------------------------------------------------------------
            DL+LL+Others      218.46      1338.21      1698.61       627.39       666.13
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1338.21 kN-m.
           -. End Moments (My2) =     1698.61 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1698.61 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1698.61 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      627.39 kN-m.
          -. End Moments (Mz2) =      666.13 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      666.13 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      666.13 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       599.341 kN.
          -. Mry        =      4674.875 kN-m.
          -. Mrz        =      1843.941 kN-m.
          -. Mr         =      5025.393 kN-m.
          -. Pu/Pr      =   0.364  --->  O.K !
          -. Muy/Mry    =   0.363  --->  O.K !
          -. Muz/Mrz    =   0.361  --->  O.K !
          -. Mu/Mr      =   0.364  --->  O.K !
          -. Ratio      =   0.364  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2156.62 kN.
          -. Vuz    =        758.58 kN.
          -. Muy    =      -1632.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =        160.53 kN.
          -. Muz    =       -718.28 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.60
```

( ). Compute shear strength of concrete.
-. Vuz = 758.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1219.07 kN.
-. phiVcz = phi * Vcz = 1097.17 kN.

-. Vuy = 160.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1176.16 kN.
-. phiVcy = phi * Vcy = 1058.54 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2112.54 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5929.41 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2112.54 kN.
-. phiVsz = phi*Vsz = 1901.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2088.15 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5972.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2088.15 kN.
-. phiVsy = phi*Vsy = 1879.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 775.377 kN.
-. Vr = 2937.878 kN.
-. Ratio = Vu / Vr = 0.264 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 861.53 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 861.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112110,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            230.39      1698.61      1996.21       666.13       693.50
           ---------------------------------------------------------------------------
            DL+LL+Others      230.39      1698.61      1996.21       666.13       693.50
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1698.61 kN-m.
           -. End Moments (My2) =     1996.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1996.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1996.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      666.13 kN-m.
          -. End Moments (Mz2) =      693.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      693.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      693.50 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       548.027 kN.
          -. Mry        =      4742.045 kN-m.
          -. Mrz        =      1650.066 kN-m.
          -. Mr         =      5020.927 kN-m.
          -. Pu/Pr      =   0.420  --->  O.K !
          -. Muy/Mry    =   0.421  --->  O.K !
          -. Muz/Mrz    =   0.420  --->  O.K !
          -. Mu/Mr      =   0.421  --->  O.K !
          -. Ratio      =   0.421  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2173.33 kN.
          -. Vuz    =        628.13 kN.
          -. Muy    =      -1953.55 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =        138.09 kN.
          -. Muz    =       -718.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 628.13 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1189.76 kN.
-. phiVcz = phi * Vcz = 1070.78 kN.

-. Vuy = 138.09 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1146.63 kN.
-. phiVcy = phi * Vcy = 1031.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2096.03 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5958.73 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2096.03 kN.
-. phiVsz = phi*Vsz = 1886.42 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2070.56 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6001.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2070.56 kN.
-. phiVsy = phi*Vsy = 1863.50 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 643.129 kN.
-. Vr = 2895.469 kN.
-. Ratio = Vu / Vr = 0.222 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 714.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 714.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0043 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0043 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112111,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            242.33      1996.21      2234.02       693.50       710.46
           ------------------------------------------------------------------------------
            DL+LL+Others      242.33      1996.21      2234.02       693.50       710.46
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1996.21 kN-m.
           -. End Moments (My2) =     2234.02 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2234.02 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2234.02 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      693.50 kN-m.
          -. End Moments (Mz2) =      710.46 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      710.46 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      710.46 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       522.791 kN.
          -. Mry        =      4783.894 kN-m.
          -. Mrz        =      1518.550 kN-m.
          -. Mr         =      5019.127 kN-m.
          -. Pu/Pr      =   0.464  --->  O.K !
          -. Muy/Mry    =   0.467  --->  O.K !
          -. Muz/Mrz    =   0.468  --->  O.K !
          -. Mu/Mr      =   0.468  --->  O.K !
          -. Ratio      =   0.468  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2190.04 kN.
          -. Vuz    =        505.14 kN.
          -. Muy    =      -2212.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.99 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.59

          -. Vuy    =        120.17 kN.
          -. Muz    =       -711.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.32 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.49
```

( ). Compute shear strength of concrete.
-. Vuz = 505.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1168.74 kN.
-. phiVcz = phi * Vcz = 1051.86 kN.

-. Vuy = 120.17 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1125.49 kN.
-. phiVcy = phi * Vcy = 1012.94 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2083.79 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5979.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2083.79 kN.
-. phiVsz = phi*Vsz = 1875.41 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2057.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6022.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2057.53 kN.
-. phiVsy = phi*Vsy = 1851.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 519.237 kN.
-. Vr = 2864.724 kN.
-. Ratio = Vu / Vr = 0.181 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 576.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 576.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0048 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112112,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            254.27      2234.02      2419.74       710.46       720.93
           ---------------------------------------------------------------------------
            DL+LL+Others      254.27      2234.02      2419.74       710.46       720.93
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2234.02 kN-m.
           -. End Moments (My2) =     2419.74 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2419.74 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2419.74 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      710.46 kN-m.
          -. End Moments (Mz2) =      720.93 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      720.93 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      720.93 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       505.217 kN.
          -. Mry        =      4810.908 kN-m.
          -. Mrz        =      1426.818 kN-m.
          -. Mr         =      5018.032 kN-m.
          -. Pu/Pr      =   0.503  --->  O.K !
          -. Muy/Mry    =   0.503  --->  O.K !
          -. Muz/Mrz    =   0.505  --->  O.K !
          -. Mu/Mr      =   0.505  --->  O.K !
          -. Ratio      =   0.505  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        254.27 kN.
          -. Vuz    =        429.22 kN.
          -. Muy    =       2419.74 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =         63.09 kN.
          -. Muz    =        720.93 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 429.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1239.14 kN.
-. phiVcz = phi * Vcz = 1115.22 kN.

-. Vuy = 63.09 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1239.14 kN.
-. phiVcy = phi * Vcy = 1115.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2123.49 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5909.35 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2123.49 kN.
-. phiVsz = phi*Vsz = 1911.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5909.35 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.49 kN.
-. phiVsy = phi*Vsy = 1911.14 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 433.828 kN.
-. Vr = 3026.365 kN.
-. Ratio = Vu / Vr = 0.143 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 482.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 482.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0084 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0084 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0084 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112113,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            266.22      2419.74      2538.87       720.93       717.52
           ------------------------------------------------------------------------------
            DL+LL+Others      266.22      2419.74      2538.87       720.93       717.52
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2419.74 kN-m.
           -. End Moments (My2) =     2538.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2538.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2538.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      717.52 kN-m.
          -. End Moments (Mz2) =      720.93 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      717.52 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      717.52 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       505.355 kN.
          -. Mry        =      4829.106 kN-m.
          -. Mrz        =      1359.893 kN-m.
          -. Mr         =      5016.929 kN-m.
          -. Pu/Pr      =   0.527  --->  O.K !
          -. Muy/Mry    =   0.526  --->  O.K !
          -. Muz/Mrz    =   0.528  --->  O.K !
          -. Mu/Mr      =   0.528  --->  O.K !
          -. Ratio      =   0.528  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        266.22 kN.
          -. Vuz    =        273.61 kN.
          -. Muy    =       2538.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =         57.16 kN.
          -. Muz    =        717.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 273.61 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1241.74 kN.
-. phiVcz = phi * Vcz = 1117.56 kN.

-. Vuy = 57.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1241.74 kN.
-. phiVcy = phi * Vcy = 1117.56 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2124.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5906.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2124.89 kN.
-. phiVsz = phi*Vsz = 1912.40 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2124.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5906.75 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2124.89 kN.
-. phiVsy = phi*Vsy = 1912.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 279.516 kN.
-. Vr = 3029.965 kN.
-. Ratio = Vu / Vr = 0.092 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 310.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 310.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0084 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0084 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0084 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112114,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            278.16      2538.87      2572.83       717.52       700.56
           ------------------------------------------------------------------------------
            DL+LL+Others      278.16      2538.87      2572.83       717.52       700.56
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2538.87 kN-m.
           -. End Moments (My2) =     2572.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2572.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2572.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      700.56 kN-m.
          -. End Moments (Mz2) =      717.52 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      700.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      700.56 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       527.360 kN.
          -. Mry        =      4842.478 kN-m.
          -. Mrz        =      1315.547 kN-m.
          -. Mr         =      5017.993 kN-m.
          -. Pu/Pr      =   0.527  --->  O.K !
          -. Muy/Mry    =   0.531  --->  O.K !
          -. Muz/Mrz    =   0.533  --->  O.K !
          -. Mu/Mr      =   0.533  --->  O.K !
          -. Ratio      =   0.533  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2240.15 kN.
          -. Vuz    =         69.63 kN.
          -. Muy    =      -2599.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.02 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.58

          -. Vuy    =         88.40 kN.
          -. Muz    =       -647.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48
```

( ). Compute shear strength of concrete.
-. Vuz = 69.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1165.11 kN.
-. phiVcz = phi * Vcz = 1048.60 kN.

-. Vuy = 88.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1121.85 kN.
-. phiVcy = phi * Vcy = 1009.66 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2081.65 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5983.38 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2081.65 kN.
-. phiVsz = phi*Vsz = 1873.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2055.25 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6026.64 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2055.25 kN.
-. phiVsy = phi*Vsy = 1849.73 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 112.531 kN.
-. Vr = 2859.390 kN.
-. Ratio = Vu / Vr = 0.039 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 125.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 125.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0049 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0049 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0049 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112115,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            278.12      2572.83      2533.64       700.56       670.23
           ---------------------------------------------------------------------------
            DL+LL+Others      278.12      2572.83      2533.64       700.56       670.23
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2533.64 kN-m.
           -. End Moments (My2) =     2572.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2572.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2572.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      670.23 kN-m.
          -. End Moments (Mz2) =      700.56 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      700.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      700.56 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       527.360 kN.
          -. Mry        =      4842.478 kN-m.
          -. Mrz        =      1315.547 kN-m.
          -. Mr         =      5017.993 kN-m.
          -. Pu/Pr      =   0.527  --->  O.K !
          -. Muy/Mry    =   0.531  --->  O.K !
          -. Muz/Mrz    =   0.533  --->  O.K !
          -. Mu/Mr      =   0.533  --->  O.K !
          -. Ratio      =   0.533  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2240.20 kN.
          -. Vuz    =         72.90 kN.
          -. Muy    =      -2599.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.58

          -. Vuy    =         97.72 kN.
          -. Muz    =       -647.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.36 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48
```

( ). Compute shear strength of concrete.
-. Vuz = 72.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1163.94 kN.
-. phiVcz = phi * Vcz = 1047.54 kN.

-. Vuy = 97.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1120.67 kN.
-. phiVcy = phi * Vcy = 1008.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2080.95 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5984.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2080.95 kN.
-. phiVsz = phi*Vsz = 1872.86 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2054.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6027.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2054.51 kN.
-. phiVsy = phi*Vsy = 1849.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 121.914 kN.
-. Vr = 2857.669 kN.
-. Ratio = Vu / Vr = 0.043 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 135.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 135.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112116,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            290.07      2533.64      2434.23       670.23       628.45
           ---------------------------------------------------------------------------
            DL+LL+Others      290.07      2533.64      2434.23       670.23       628.45
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2434.23 kN-m.
           -. End Moments (My2) =     2533.64 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2533.64 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2533.64 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      628.45 kN-m.
          -. End Moments (Mz2) =      670.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      670.23 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      670.23 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       555.532 kN.
          -. Mry        =      4853.374 kN-m.
          -. Mrz        =      1282.303 kN-m.
          -. Mr         =      5019.915 kN-m.
          -. Pu/Pr      =   0.522  --->  O.K !
          -. Muy/Mry    =   0.522  --->  O.K !
          -. Muz/Mrz    =   0.523  --->  O.K !
          -. Mu/Mr      =   0.523  --->  O.K !
          -. Ratio      =   0.523  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2256.90 kN.
          -. Vuz    =        194.31 kN.
          -. Muy    =      -2569.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56

          -. Vuy    =        107.29 kN.
          -. Muz    =       -607.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.46
```

( ). Compute shear strength of concrete.
-. Vuz = 194.31 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1156.02 kN.
-. phiVcz = phi * Vcz = 1040.42 kN.

-. Vuy = 107.29 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1112.73 kN.
-. phiVcy = phi * Vcy = 1001.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2076.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5992.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2076.23 kN.
-. phiVsz = phi*Vsz = 1868.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2049.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6035.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2049.49 kN.
-. phiVsy = phi*Vsy = 1844.54 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 221.967 kN.
-. Vr = 2845.991 kN.
-. Ratio = Vu / Vr = 0.078 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 246.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 246.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0050 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0050 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0050 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112117,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            302.02      2434.23      2287.88       628.45       578.28
           ------------------------------------------------------------------------------
            DL+LL+Others      302.02      2434.23      2287.88       628.45       578.28
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2287.88 kN-m.
           -. End Moments (My2) =     2434.23 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2434.23 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2434.23 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      578.28 kN-m.
          -. End Moments (Mz2) =      628.45 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      628.45 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      628.45 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       603.920 kN.
          -. Mry        =      4864.515 kN-m.
          -. Mrz        =      1255.580 kN-m.
          -. Mr         =      5023.941 kN-m.
          -. Pu/Pr      =   0.500  --->  O.K !
          -. Muy/Mry    =   0.500  --->  O.K !
          -. Muz/Mrz    =   0.501  --->  O.K !
          -. Mu/Mr      =   0.501  --->  O.K !
          -. Ratio      =   0.501  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2273.59 kN.
          -. Vuz    =        289.57 kN.
          -. Muy    =      -2476.86 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56

          -. Vuy    =        113.49 kN.
          -. Muz    =       -559.88 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.41 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.47
```

( ). Compute shear strength of concrete.
-. Vuz = 289.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1158.43 kN.
-. phiVcz = phi * Vcz = 1042.59 kN.

-. Vuy = 113.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1115.15 kN.
-. phiVcy = phi * Vcy = 1003.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2077.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5990.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2077.67 kN.
-. phiVsz = phi*Vsz = 1869.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2051.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6033.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2051.02 kN.
-. phiVsy = phi*Vsy = 1845.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 311.013 kN.
-. Vr = 2849.555 kN.
-. Ratio = Vu / Vr = 0.109 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 345.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 345.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0049 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0049 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0049 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112118,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            313.97      2287.88      2107.57       578.28       522.67
           ------------------------------------------------------------------------------
            DL+LL+Others      313.97      2287.88      2107.57       578.28       522.67
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2107.57 kN-m.
           -. End Moments (My2) =     2287.88 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2287.88 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2287.88 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      522.67 kN-m.
          -. End Moments (Mz2) =      578.28 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      578.28 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      578.28 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       665.622 kN.
          -. Mry        =      4876.634 kN-m.
          -. Mrz        =      1233.504 kN-m.
          -. Mr         =      5030.218 kN-m.
          -. Pu/Pr      =   0.472  --->  O.K !
          -. Muy/Mry    =   0.469  --->  O.K !
          -. Muz/Mrz    =   0.469  --->  O.K !
          -. Mu/Mr      =   0.472  --->  O.K !
          -. Ratio      =   0.472  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2290.29 kN.
          -. Vuz    =        358.95 kN.
          -. Muy    =      -2334.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.59

          -. Vuy    =        115.79 kN.
          -. Muz    =       -506.94 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.50
```

( ). Compute shear strength of concrete.
-. Vuz = 358.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1170.81 kN.
-. phiVcz = phi * Vcz = 1053.73 kN.

-. Vuy = 115.79 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1127.58 kN.
-. phiVcy = phi * Vcy = 1014.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2085.02 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5977.67 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2085.02 kN.
-. phiVsz = phi*Vsz = 1876.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2058.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6020.91 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2058.84 kN.
-. phiVsy = phi*Vsy = 1852.95 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 377.167 kN.
-. Vr = 2867.773 kN.
-. Ratio = Vu / Vr = 0.132 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 419.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 419.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112119,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            325.93      2107.57      1905.49       522.67       464.38
           ------------------------------------------------------------------------------
            DL+LL+Others      325.93      2107.57      1905.49       522.67       464.38
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1905.49 kN-m.
           -. End Moments (My2) =     2107.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2107.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2107.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      464.38 kN-m.
          -. End Moments (Mz2) =      522.67 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      522.67 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      522.67 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       758.788 kN.
          -. Mry        =      4891.043 kN-m.
          -. Mrz        =      1215.146 kN-m.
          -. Mr         =      5039.730 kN-m.
          -. Pu/Pr      =   0.430  --->  O.K !
          -. Muy/Mry    =   0.431  --->  O.K !
          -. Muz/Mrz    =   0.430  --->  O.K !
          -. Mu/Mr      =   0.431  --->  O.K !
          -. Ratio      =   0.431  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2306.98 kN.
          -. Vuz    =        404.56 kN.
          -. Muy    =      -2156.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.64

          -. Vuy    =        115.01 kN.
          -. Muz    =       -451.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 404.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1191.75 kN.
-. phiVcz = phi * Vcz = 1072.58 kN.

-. Vuy = 115.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1148.64 kN.
-. phiVcy = phi * Vcy = 1033.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2097.17 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5956.73 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2097.17 kN.
-. phiVsz = phi*Vsz = 1887.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2071.78 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5999.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2071.78 kN.
-. phiVsy = phi*Vsy = 1864.60 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 420.594 kN.
-. Vr = 2898.370 kN.
-. Ratio = Vu / Vr = 0.145 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 467.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 467.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112120,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            337.89      1905.49      1692.82       464.38       405.94
           ------------------------------------------------------------------------------
            DL+LL+Others      337.89      1905.49      1692.82       464.38       405.94
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1692.82 kN-m.
           -. End Moments (My2) =     1905.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1905.49 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1905.49 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      405.94 kN-m.
          -. End Moments (Mz2) =      464.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      464.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      464.38 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       873.237 kN.
          -. Mry        =      4906.011 kN-m.
          -. Mrz        =      1194.640 kN-m.
          -. Mr         =      5049.367 kN-m.
          -. Pu/Pr      =   0.387  --->  O.K !
          -. Muy/Mry    =   0.388  --->  O.K !
          -. Muz/Mrz    =   0.389  --->  O.K !
          -. Mu/Mr      =   0.389  --->  O.K !
          -. Ratio      =   0.389  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2323.67 kN.
          -. Vuz    =        428.60 kN.
          -. Muy    =      -1953.90 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =        110.80 kN.
          -. Muz    =       -395.04 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61
```

( ). Compute shear strength of concrete.
-. Vuz = 428.60 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1219.98 kN.
-. phiVcz = phi * Vcz = 1097.98 kN.

-. Vuy = 110.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1177.08 kN.
-. phiVcy = phi * Vcy = 1059.37 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2113.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5928.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2113.04 kN.
-. phiVsz = phi*Vsz = 1901.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2088.69 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5971.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2088.69 kN.
-. phiVsy = phi*Vsy = 1879.82 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 442.695 kN.
-. Vr = 2939.186 kN.
-. Ratio = Vu / Vr = 0.151 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 491.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 491.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112121,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            349.84      1692.82      1479.57       405.94       349.51
           ------------------------------------------------------------------------------
            DL+LL+Others      349.84      1692.82      1479.57       405.94       349.51
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1479.57 kN-m.
           -. End Moments (My2) =     1692.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1692.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1692.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      349.51 kN-m.
          -. End Moments (Mz2) =      405.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      405.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      405.94 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1024.672 kN.
          -. Mry        =      4923.467 kN-m.
          -. Mrz        =      1174.852 kN-m.
          -. Mr         =      5061.700 kN-m.
          -. Pu/Pr      =   0.341  --->  O.K !
          -. Muy/Mry    =   0.344  --->  O.K !
          -. Muz/Mrz    =   0.346  --->  O.K !
          -. Mu/Mr      =   0.346  --->  O.K !
          -. Ratio      =   0.346  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2340.36 kN.
          -. Vuz    =        432.02 kN.
          -. Muy    =      -1739.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        104.06 kN.
          -. Muz    =       -340.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.68 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.68
```

( ). Compute shear strength of concrete.
-. Vuz = 432.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1254.42 kN.
-. phiVcz = phi * Vcz = 1128.98 kN.

-. Vuy = 104.06 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1211.85 kN.
-. phiVcy = phi * Vcy = 1090.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2131.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5894.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2131.66 kN.
-. phiVsz = phi*Vsz = 1918.49 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2108.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5936.63 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2108.53 kN.
-. phiVsy = phi*Vsy = 1897.68 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 444.377 kN.
-. Vr = 2988.347 kN.
-. Ratio = Vu / Vr = 0.149 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 493.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 493.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112122,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2357.05     -1523.66     -1314.95      -288.89      -242.07
           ------------------------------------------------------------------------------
            DL+LL+Others     2357.05     -1523.66     -1314.95      -288.89      -242.07
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1314.95 kN-m.
           -. End Moments (My2) =     1523.66 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1523.66 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1523.66 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      242.07 kN-m.
          -. End Moments (Mz2) =      288.89 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -288.89 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -288.89 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

( ). Check tensile reinforcement.
-. Rho = 0.0321
-. Rho > Rho_max ---> Not Acceptable !!!

( ). Check moment capacity.
-. Pr_max = 24404.708 kN.
-. Pr = 7765.547 kN.
-. Mry = 4987.850 kN-m.
-. Mrz = 951.922 kN-m.
-. Mr = 5077.874 kN-m.
-. Pu/Pr = 0.304 ---> O.K !
-. Muy/Mry = 0.305 ---> O.K !
-. Muz/Mrz = 0.303 ---> O.K !
-. Mu/Mr = 0.305 ---> O.K !
-. Ratio = 0.305 ---> O.K !

[[[*]]] ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.

( ). Compute shear parameter. (LCB = 151, POS = I)
-. phi = 0.90
-. Av = 0.0006 m^2.
-. Pu = 2357.05 kN.
-. Vuz = 417.46 kN.
-. Muy = -1523.66 kN-m.
-. bvz = 1.20 m.
-. dvz = MAX[dvz_calc, 0.9*dz, 0.72*Hc] = 0.86 m.
-. thetaz = 32.16 Deg. [Clause 5.8.3.4.2]
-. betaz = 2.86

-. Vuy = 94.56 kN.
-. Muz = -288.89 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 32.42 Deg. [Clause 5.8.3.4.2]
-. betay = 2.77

( ). Compute shear strength of concrete.
-. Vuz = 417.46 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1293.81 kN.
-. phiVcz = phi * Vcz = 1164.43 kN.

-. Vuy = 94.56 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1251.73 kN.
-. phiVcy = phi * Vcy = 1126.56 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2151.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5854.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2151.99 kN.
-. phiVsz = phi*Vsz = 1936.79 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2130.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5896.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2130.23 kN.
-. phiVsy = phi*Vsy = 1917.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 428.036 kN.
-. Vr = 3043.762 kN.
-. Ratio = Vu / Vr = 0.141 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 475.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 475.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112123,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2373.73     -1314.95     -1120.31      -242.07      -200.69
           ------------------------------------------------------------------------------
            DL+LL+Others     2373.73     -1314.95     -1120.31      -242.07      -200.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1120.31 kN-m.
           -. End Moments (My2) =     1314.95 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1314.95 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1314.95 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      200.69 kN-m.
          -. End Moments (Mz2) =      242.07 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -242.07 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -242.07 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8732.584 kN.
          -. Mry        =      4857.934 kN-m.
          -. Mrz        =       887.088 kN-m.
          -. Mr         =      4938.263 kN-m.
          -. Pu/Pr      =   0.272  --->  O.K !
          -. Muy/Mry    =   0.271  --->  O.K !
          -. Muz/Mrz    =   0.273  --->  O.K !
          -. Mu/Mr      =   0.273  --->  O.K !
          -. Ratio      =   0.273  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2373.73 kN.
          -. Vuz    =        389.28 kN.
          -. Muy    =      -1314.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96

          -. Vuy    =         83.45 kN.
          -. Muz    =       -242.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 389.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1336.44 kN.
-. phiVcz = phi * Vcz = 1202.79 kN.

-. Vuy = 83.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1295.03 kN.
-. phiVcy = phi * Vcy = 1165.52 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2172.93 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5812.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2172.93 kN.
-. phiVsz = phi*Vsz = 1955.64 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2152.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5853.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2152.60 kN.
-. phiVsy = phi*Vsy = 1937.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 398.122 kN.
-. Vr = 3102.866 kN.
-. Ratio = Vu / Vr = 0.128 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 442.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 442.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112124,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2390.41     -1120.31      -939.71      -200.69      -163.74
           ------------------------------------------------------------------------------
            DL+LL+Others     2390.41     -1120.31      -939.71      -200.69      -163.74
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      939.71 kN-m.
           -. End Moments (My2) =     1120.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1120.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1120.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      163.74 kN-m.
          -. End Moments (Mz2) =      200.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -200.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -200.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10153.466 kN.
          -. Mry        =      4745.097 kN-m.
          -. Mrz        =       843.087 kN-m.
          -. Mr         =      4819.412 kN-m.
          -. Pu/Pr      =   0.235  --->  O.K !
          -. Muy/Mry    =   0.236  --->  O.K !
          -. Muz/Mrz    =   0.238  --->  O.K !
          -. Mu/Mr      =   0.238  --->  O.K !
          -. Ratio      =   0.238  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2390.41 kN.
          -. Vuz    =        361.20 kN.
          -. Muy    =      -1120.31 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.67 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.05

          -. Vuy    =         74.51 kN.
          -. Muz    =       -200.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.90 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96
```

( ). Compute shear strength of concrete.
-. Vuz = 361.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1378.86 kN.
-. phiVcz = phi * Vcz = 1240.98 kN.

-. Vuy = 74.51 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1338.25 kN.
-. phiVcy = phi * Vcy = 1204.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2192.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5769.62 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2192.75 kN.
-. phiVsz = phi*Vsz = 1973.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2173.80 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5810.23 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2173.80 kN.
-. phiVsy = phi*Vsy = 1956.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 368.807 kN.
-. Vr = 3160.847 kN.
-. Ratio = Vu / Vr = 0.117 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 409.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 409.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112125,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2407.09      -939.71      -775.76      -163.74      -131.44
           ---------------------------------------------------------------------------
            DL+LL+Others     2407.09      -939.71      -775.76      -163.74      -131.44
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      775.76 kN-m.
           -. End Moments (My2) =      939.71 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -939.71 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -939.71 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      131.44 kN-m.
          -. End Moments (Mz2) =      163.74 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -163.74 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -163.74 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11833.555 kN.
          -. Mry        =      4589.420 kN-m.
          -. Mrz        =       804.818 kN-m.
          -. Mr         =      4659.454 kN-m.
          -. Pu/Pr      =   0.203  --->  O.K !
          -. Muy/Mry    =   0.205  --->  O.K !
          -. Muz/Mrz    =   0.203  --->  O.K !
          -. Mu/Mr      =   0.205  --->  O.K !
          -. Ratio      =   0.205  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2407.09 kN.
          -. Vuz    =        327.89 kN.
          -. Muy    =       -939.71 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.45 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.15

          -. Vuy    =         65.13 kN.
          -. Muz    =       -163.74 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.65 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.06
```

( ). Compute shear strength of concrete.
-. Vuz = 327.89 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1421.90 kN.
-. phiVcz = phi * Vcz = 1279.71 kN.

-. Vuy = 65.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1382.23 kN.
-. phiVcy = phi * Vcy = 1244.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2211.90 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5726.59 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2211.90 kN.
-. phiVsz = phi*Vsz = 1990.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2194.29 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5766.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2194.29 kN.
-. phiVsy = phi*Vsy = 1974.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 334.300 kN.
-. Vr = 3218.871 kN.
-. Ratio = Vu / Vr = 0.104 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 371.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 371.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112126,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2423.77      -775.76      -630.08      -131.44      -103.82
           ------------------------------------------------------------------------------
            DL+LL+Others     2423.77      -775.76      -630.08      -131.44      -103.82
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      630.08 kN-m.
           -. End Moments (My2) =      775.76 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -775.76 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -775.76 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      103.82 kN-m.
          -. End Moments (Mz2) =      131.44 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -131.44 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -131.44 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     13716.125 kN.
           -. Mry        =      4392.410 kN-m.
           -. Mrz        =       737.017 kN-m.
           -. Mr         =      4453.814 kN-m.
           -. Pu/Pr      =   0.177  --->  O.K !
           -. Muy/Mry    =   0.177  --->  O.K !
           -. Muz/Mrz    =   0.178  --->  O.K !
           -. Mu/Mr      =   0.178  --->  O.K !
           -. Ratio      =   0.178  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2423.77 kN.
           -. Vuz    =        291.38 kN.
           -. Muy    =       -775.76 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.24 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.24

           -. Vuy    =         55.67 kN.
           -. Muz    =       -131.44 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  31.43 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.16
```

( ). Compute shear strength of concrete.
-. Vuz = 291.38 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1464.39 kN.
-. phiVcz = phi * Vcz = 1317.95 kN.

-. Vuy = 55.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1425.81 kN.
-. phiVcy = phi * Vcy = 1283.23 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2229.92 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5684.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2229.92 kN.
-. phiVsz = phi*Vsz = 2006.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2213.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5722.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2213.59 kN.
-. phiVsy = phi*Vsy = 1992.23 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 296.648 kN.
-. Vr = 3275.460 kN.
-. Ratio = Vu / Vr = 0.091 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 329.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 329.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112127,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2440.45      -630.08      -502.26      -103.82       -80.51
           ---------------------------------------------------------------------------
            DL+LL+Others     2440.45      -630.08      -502.26      -103.82       -80.51
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      502.26 kN-m.
           -. End Moments (My2) =      630.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -630.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -630.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       80.51 kN-m.
          -. End Moments (Mz2) =      103.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -103.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -103.82 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15824.616 kN.
          -. Mry        =      4117.007 kN-m.
          -. Mrz        =       680.436 kN-m.
          -. Mr         =      4172.858 kN-m.
          -. Pu/Pr      =   0.154  --->  O.K !
          -. Muy/Mry    =   0.153  --->  O.K !
          -. Muz/Mrz    =   0.153  --->  O.K !
          -. Mu/Mr      =   0.154  --->  O.K !
          -. Ratio      =   0.154  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2440.45 kN.
          -. Vuz    =        255.63 kN.
          -. Muy    =       -630.08 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.33

          -. Vuy    =         46.98 kN.
          -. Muz    =       -103.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 255.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1504.78 kN.
-. phiVcz = phi * Vcz = 1354.30 kN.

-. Vuy = 46.98 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1467.35 kN.
-. phiVcy = phi * Vcy = 1320.62 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2246.28 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5643.71 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2246.28 kN.
-. phiVsz = phi*Vsz = 2021.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2231.14 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5681.13 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2231.14 kN.
-. phiVsy = phi*Vsy = 2008.03 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 259.916 kN.
-. Vr = 3328.645 kN.
-. Ratio = Vu / Vr = 0.078 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 288.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 288.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112128,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2457.12      -502.26      -386.49       -80.51       -60.02
           ------------------------------------------------------------------------------
            DL+LL+Others     2457.12      -502.26      -386.49       -80.51       -60.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      386.49 kN-m.
           -. End Moments (My2) =      502.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -502.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -502.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       60.02 kN-m.
          -. End Moments (Mz2) =       80.51 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -80.51 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -80.51 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     18133.235 kN.
          -. Mry        =      3741.625 kN-m.
          -. Mrz        =       592.109 kN-m.
          -. Mr         =      3788.186 kN-m.
          -. Pu/Pr      =   0.136  --->  O.K !
          -. Muy/Mry    =   0.134  --->  O.K !
          -. Muz/Mrz    =   0.136  --->  O.K !
          -. Mu/Mr      =   0.136  --->  O.K !
          -. Ratio      =   0.136  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2457.12 kN.
          -. Vuz    =        231.54 kN.
          -. Muy    =       -502.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.41

          -. Vuy    =         41.41 kN.
          -. Muz    =        -80.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.33
```

( ). Compute shear strength of concrete.
-. Vuz = 231.54 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1540.20 kN.
-. phiVcz = phi * Vcz = 1386.18 kN.

-. Vuy = 41.41 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1503.88 kN.
-. phiVcy = phi * Vcy = 1353.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2260.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5608.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2260.06 kN.
-. phiVsz = phi*Vsz = 2034.06 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2245.93 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5644.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2245.93 kN.
-. phiVsy = phi*Vsy = 2021.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 235.212 kN.
-. Vr = 3374.830 kN.
-. Ratio = Vu / Vr = 0.070 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 261.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 261.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112129,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2473.79      -386.49      -282.16       -60.02       -42.10
           ------------------------------------------------------------------------------
            DL+LL+Others     2473.79      -386.49      -282.16       -60.02       -42.10
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      282.16 kN-m.
           -. End Moments (My2) =      386.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -386.49 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -386.49 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       42.10 kN-m.
          -. End Moments (Mz2) =       60.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -60.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -60.02 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     20629.556 kN.
          -. Mry        =      3224.564 kN-m.
          -. Mrz        =       504.166 kN-m.
          -. Mr         =      3263.740 kN-m.
          -. Pu/Pr      =   0.120  --->  O.K !
          -. Muy/Mry    =   0.120  --->  O.K !
          -. Muz/Mrz    =   0.119  --->  O.K !
          -. Mu/Mr      =   0.120  --->  O.K !
          -. Ratio      =   0.120  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2473.79 kN.
          -. Vuz    =        208.68 kN.
          -. Muy    =       -386.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.48

          -. Vuy    =         36.35 kN.
          -. Muz    =        -60.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.41
```

( ). Compute shear strength of concrete.
-. Vuz = 208.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1573.77 kN.
-. phiVcz = phi * Vcz = 1416.39 kN.

-. Vuy = 36.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1538.60 kN.
-. phiVcy = phi * Vcy = 1384.74 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2272.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5574.72 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2272.66 kN.
-. phiVsz = phi*Vsz = 2045.40 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2259.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5609.88 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2259.45 kN.
-. phiVsy = phi*Vsy = 2033.51 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 211.820 kN.
-. Vr = 3418.251 kN.
-. Ratio = Vu / Vr = 0.062 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 235.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 235.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112130,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2678.43      -183.15      -122.51       -71.84       -46.42
           ------------------------------------------------------------------------------
            DL+LL+Others     2678.43      -183.15      -122.51       -71.84       -46.42
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      122.51 kN-m.
           -. End Moments (My2) =      183.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -122.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -122.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       46.42 kN-m.
          -. End Moments (Mz2) =       71.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -46.42 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -46.42 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =      1116.442 kN-m.
           -. Mrz        =       422.486 kN-m.
           -. Mr         =      1193.708 kN-m.
           -. Pu/Pr      =   0.110  --->  O.K !
           -. Muy/Mry    =   0.110  --->  O.K !
           -. Muz/Mrz    =   0.110  --->  O.K !
           -. Mu/Mr      =   0.110  --->  O.K !
           -. Ratio      =   0.110  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2490.46 kN.
           -. Vuz    =        187.67 kN.
           -. Muy    =       -282.16 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  30.64 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.55

           -. Vuy    =         31.89 kN.
           -. Muz    =        -42.10 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  30.77 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.48
```

( ). Compute shear strength of concrete.
-. Vuz = 187.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1605.17 kN.
-. phiVcz = phi * Vcz = 1444.66 kN.

-. Vuy = 31.89 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1571.16 kN.
-. phiVcy = phi * Vcy = 1414.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2284.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5543.31 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2284.06 kN.
-. phiVsz = phi*Vsz = 2055.65 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2271.70 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5577.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2271.70 kN.
-. phiVsy = phi*Vsy = 2044.53 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 190.362 kN.
-. Vr = 3458.571 kN.
-. Ratio = Vu / Vr = 0.055 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 211.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 211.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112131,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2695.11      -122.51       -73.56       -46.42       -26.51
           ------------------------------------------------------------------------------
            DL+LL+Others     2695.11      -122.51       -73.56       -46.42       -26.51
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       73.56 kN-m.
           -. End Moments (My2) =      122.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -73.56 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -73.56 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       26.51 kN-m.
          -. End Moments (Mz2) =       46.42 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -26.51 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -26.51 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       666.341 kN-m.
          -. Mrz        =       239.455 kN-m.
          -. Mr         =       708.060 kN-m.
          -. Pu/Pr      =   0.110  --->  O.K !
          -. Muy/Mry    =   0.110  --->  O.K !
          -. Muz/Mrz    =   0.111  --->  O.K !
          -. Mu/Mr      =   0.111  --->  O.K !
          -. Ratio      =   0.111  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2507.13 kN.
          -. Vuz    =        151.25 kN.
          -. Muy    =       -188.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.63

          -. Vuy    =         24.47 kN.
          -. Muz    =        -26.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.63 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.55
```

( ). Compute shear strength of concrete.
-. Vuz = 151.25 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1638.66 kN.
-. phiVcz = phi * Vcz = 1474.79 kN.

-. Vuy = 24.47 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1605.95 kN.
-. phiVcy = phi * Vcy = 1445.36 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2295.81 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5509.83 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2295.81 kN.
-. phiVsz = phi*Vsz = 2066.23 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2284.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5542.53 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2284.34 kN.
-. phiVsy = phi*Vsy = 2055.90 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 153.221 kN.
-. Vr = 3501.262 kN.
-. Ratio = Vu / Vr = 0.044 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 170.25 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 170.25 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112132,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2711.78       -73.56       -39.55       -26.51       -13.39
           ------------------------------------------------------------------------------
            DL+LL+Others     2711.78       -73.56       -39.55       -26.51       -13.39
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       39.55 kN-m.
           -. End Moments (My2) =       73.56 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -39.55 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -39.55 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       13.39 kN-m.
          -. End Moments (Mz2) =       26.51 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -13.39 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -13.39 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       355.770 kN-m.
          -. Mrz        =       120.939 kN-m.
          -. Mr         =       375.764 kN-m.
          -. Pu/Pr      =   0.111  --->  O.K !
          -. Muy/Mry    =   0.111  --->  O.K !
          -. Muz/Mrz    =   0.111  --->  O.K !
          -. Mu/Mr      =   0.111  --->  O.K !
          -. Ratio      =   0.111  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2523.80 kN.
          -. Vuz    =        104.81 kN.
          -. Muy    =       -112.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.70

          -. Vuy    =         15.58 kN.
          -. Muz    =        -14.79 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.63
```

( ). Compute shear strength of concrete.
-. Vuz = 104.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1670.65 kN.
-. phiVcz = phi * Vcz = 1503.58 kN.

-. Vuy = 15.58 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1639.28 kN.
-. phiVcy = phi * Vcy = 1475.35 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2306.69 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5477.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2306.69 kN.
-. phiVsz = phi*Vsz = 2076.02 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2296.03 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5509.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2296.03 kN.
-. phiVsy = phi*Vsy = 2066.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 105.961 kN.
-. Vr = 3541.780 kN.
-. Ratio = Vu / Vr = 0.030 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 117.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 117.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112133,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2728.45       -39.55       -17.86       -13.39        -5.63
           ------------------------------------------------------------------------------
            DL+LL+Others     2728.45       -39.55       -17.86       -13.39        -5.63
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       17.86 kN-m.
           -. End Moments (My2) =       39.55 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -17.86 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -17.86 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        5.63 kN-m.
          -. End Moments (Mz2) =       13.39 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -5.63 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -5.63 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       159.767 kN-m.
          -. Mrz        =        50.424 kN-m.
          -. Mr         =       167.536 kN-m.
          -. Pu/Pr      =   0.112  --->  O.K !
          -. Muy/Mry    =   0.112  --->  O.K !
          -. Muz/Mrz    =   0.112  --->  O.K !
          -. Mu/Mr      =   0.112  --->  O.K !
          -. Ratio      =   0.112  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2557.12 kN.
          -. Vuz    =         66.53 kN.
          -. Muy    =        -27.03 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.75

          -. Vuy    =          8.93 kN.
          -. Muz    =         -3.63 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.42 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.68
```

( ). Compute shear strength of concrete.
-. Vuz = 66.53 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1693.10 kN.
-. phiVcz = phi * Vcz = 1523.79 kN.

-. Vuy = 8.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1662.72 kN.
-. phiVcy = phi * Vcy = 1496.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2314.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5455.38 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2314.12 kN.
-. phiVsz = phi*Vsz = 2082.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2304.02 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5485.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2304.02 kN.
-. phiVsy = phi*Vsy = 2073.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 67.122 kN.
-. Vr = 3570.073 kN.
-. Ratio = Vu / Vr = 0.019 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 74.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 74.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112134,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2745.11       -17.86        -5.85        -5.63        -1.71
           ------------------------------------------------------------------------------
            DL+LL+Others     2745.11       -17.86        -5.85        -5.63        -1.71
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        5.85 kN-m.
           -. End Moments (My2) =       17.86 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -5.85 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -5.85 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.71 kN-m.
          -. End Moments (Mz2) =        5.63 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.71 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.71 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        51.971 kN-m.
          -. Mrz        =        15.195 kN-m.
          -. Mr         =        54.147 kN-m.
          -. Pu/Pr      =   0.112  --->  O.K !
          -. Muy/Mry    =   0.112  --->  O.K !
          -. Muz/Mrz    =   0.113  --->  O.K !
          -. Mu/Mr      =   0.113  --->  O.K !
          -. Ratio      =   0.113  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2573.78 kN.
          -. Vuz    =         36.63 kN.
          -. Muy    =         -8.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.78

          -. Vuy    =          4.60 kN.
          -. Muz    =         -1.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.37 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.71
```

( ). Compute shear strength of concrete.
-. Vuz = 36.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1706.90 kN.
-. phiVcz = phi * Vcz = 1536.21 kN.

-. Vuy = 4.60 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1677.15 kN.
-. phiVcy = phi * Vcy = 1509.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2318.60 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5441.59 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2318.60 kN.
-. phiVsz = phi*Vsz = 2086.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2308.85 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5471.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2308.85 kN.
-. phiVsy = phi*Vsy = 2077.97 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 36.915 kN.
-. Vr = 3587.398 kN.
-. Ratio = Vu / Vr = 0.010 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 41.02 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 41.02 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112135,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2761.78        -5.85        -0.79        -1.71        -0.29
           ------------------------------------------------------------------------------
            DL+LL+Others     2761.78        -5.85        -0.79        -1.71        -0.29
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.79 kN-m.
           -. End Moments (My2) =        5.85 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.29 kN-m.
          -. End Moments (Mz2) =        1.71 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.29 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         7.021 kN-m.
          -. Mrz        =         2.523 kN-m.
          -. Mr         =         7.461 kN-m.
          -. Pu/Pr      =   0.113  --->  O.K !
          -. Muy/Mry    =   0.113  --->  O.K !
          -. Muz/Mrz    =   0.113  --->  O.K !
          -. Mu/Mr      =   0.113  --->  O.K !
          -. Ratio      =   0.113  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2590.44 kN.
          -. Vuz    =         15.19 kN.
          -. Muy    =         -1.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.80

          -. Vuy    =          2.34 kN.
          -. Muz    =         -0.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.33 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.73
```

( ). Compute shear strength of concrete.
-. Vuz = 15.19 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1716.23 kN.
-. phiVcz = phi * Vcz = 1544.61 kN.

-. Vuy = 2.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1686.91 kN.
-. phiVcy = phi * Vcy = 1518.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2321.60 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5432.26 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2321.60 kN.
-. phiVsz = phi*Vsz = 2089.44 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2312.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5461.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2312.08 kN.
-. phiVsy = phi*Vsy = 2080.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.374 kN.
-. Vr = 3599.092 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.08 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.08 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112136,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2778.44        -0.79         0.00        -0.29         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     2778.44        -0.79         0.00        -0.29         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y             =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z             =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.114  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.114  --->  O.K !
          -. Ratio      =   0.114  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2607.10 kN.
          -. Vuz    =          2.25 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.74

          -. Vuy    =          0.93 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.74
```

( ). Compute shear strength of concrete.
-. Vuz = 2.25 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1691.88 kN.
-. phiVcz = phi * Vcz = 1522.70 kN.

-. Vuy = 0.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1691.88 kN.
-. phiVcy = phi * Vcy = 1522.70 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2313.72 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5456.60 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2313.72 kN.
-. phiVsz = phi*Vsz = 2082.34 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2313.72 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5456.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2313.72 kN.
-. phiVsy = phi*Vsy = 2082.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 2.432 kN.
-. Vr = 3605.040 kN.
-. Ratio = Vu / Vr =6.746e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 2.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 2.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112202,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            214.50      3097.59      2244.19      2173.32      1781.97
           ------------------------------------------------------------------------------
            DL+LL+Others      214.50      3097.59      2244.19      2173.32      1781.97
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2244.19 kN-m.
           -. End Moments (My2) =     3097.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     3097.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     3097.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1781.97 kN-m.
          -. End Moments (Mz2) =     2173.32 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2173.32 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2173.32 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       285.487 kN.
          -. Mry        =      4086.143 kN-m.
          -. Mrz        =      2861.623 kN-m.
          -. Mr         =      4988.531 kN-m.
          -. Pu/Pr      =   0.751  --->  O.K !
          -. Muy/Mry    =   0.758  --->  O.K !
          -. Muz/Mrz    =   0.759  --->  O.K !
          -. Mu/Mr      =   0.759  --->  O.K !
          -. Ratio      =   0.759  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        214.50 kN.
          -. Vuz    =       1708.62 kN.
          -. Muy    =       3097.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  35.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.02

          -. Vuy    =        792.12 kN.
          -. Muz    =       2173.32 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.40 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.02
```

( ). Compute shear strength of concrete.
-. Vuz = 1708.62 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 914.35 kN.
-. phiVcz = phi * Vcz = 822.91 kN.

-. Vuy = 792.12 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 914.35 kN.
-. phiVcy = phi * Vcy = 822.91 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1903.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6234.14 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1903.52 kN.
-. phiVsz = phi*Vsz = 1713.17 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1903.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6234.14 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1903.52 kN.
-. phiVsy = phi*Vsy = 1713.17 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1883.307 kN.
-. Vr = 2536.083 kN.
-. Ratio = Vu / Vr = 0.743 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1903.52 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1903.52 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0153 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0153 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0153 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112203,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            226.42      2244.19      1460.39      1781.97      1417.21
           ------------------------------------------------------------------------------
            DL+LL+Others      226.42      2244.19      1460.39      1781.97      1417.21
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1460.39 kN-m.
           -. End Moments (My2) =     2244.19 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2244.19 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2244.19 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1417.21 kN-m.
          -. End Moments (Mz2) =     1781.97 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1781.97 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1781.97 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       396.542 kN.
          -. Mry        =      3922.309 kN-m.
          -. Mrz        =      3113.593 kN-m.
          -. Mr         =      5007.890 kN-m.
          -. Pu/Pr      =   0.571  --->  O.K !
          -. Muy/Mry    =   0.572  --->  O.K !
          -. Muz/Mrz    =   0.572  --->  O.K !
          -. Mu/Mr      =   0.572  --->  O.K !
          -. Ratio      =   0.572  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        226.42 kN.
          -. Vuz    =       1570.87 kN.
          -. Muy    =       2244.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.27

          -. Vuy    =        743.10 kN.
          -. Muz    =       1781.97 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.27
```

( ). Compute shear strength of concrete.
-. Vuz = 1570.87 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1026.40 kN.
-. phiVcz = phi * Vcz = 923.76 kN.

-. Vuy = 743.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1026.40 kN.
-. phiVcy = phi * Vcy = 923.76 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1991.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6122.08 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1991.15 kN.
-. phiVsz = phi*Vsz = 1792.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1991.15 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6122.08 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1991.15 kN.
-. phiVsy = phi*Vsy = 1792.04 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1737.766 kN.
-. Vr = 2715.803 kN.
-. Ratio = Vu / Vr = 0.640 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1930.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1930.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0120 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0120 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0120 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112204,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            238.35      1460.39       749.90      1417.21      1083.42
           ---------------------------------------------------------------------------
            DL+LL+Others      238.35      1460.39       749.90      1417.21      1083.42
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      749.90 kN-m.
           -. End Moments (My2) =     1460.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1460.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1460.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1083.42 kN-m.
          -. End Moments (Mz2) =     1417.21 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1417.21 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1417.21 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       582.558 kN.
          -. Mry        =      3607.589 kN-m.
          -. Mrz        =      3495.973 kN-m.
          -. Mr         =      5023.597 kN-m.
          -. Pu/Pr      =   0.409  --->  O.K !
          -. Muy/Mry    =   0.405  --->  O.K !
          -. Muz/Mrz    =   0.405  --->  O.K !
          -. Mu/Mr      =   0.409  --->  O.K !
          -. Ratio      =   0.409  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        238.35 kN.
          -. Vuz    =       1429.56 kN.
          -. Muy    =       1460.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56

          -. Vuy    =        691.44 kN.
          -. Muz    =       1417.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56
```

( ). Compute shear strength of concrete.
-. Vuz = 1429.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1156.70 kN.
-. phiVcz = phi * Vcz = 1041.03 kN.

-. Vuy = 691.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1156.70 kN.
-. phiVcy = phi * Vcy = 1041.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2076.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5991.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2076.63 kN.
-. phiVsz = phi*Vsz = 1868.97 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2076.63 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5991.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2076.63 kN.
-. phiVsy = phi*Vsy = 1868.97 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1587.996 kN.
-. Vr = 2909.995 kN.
-. Ratio = Vu / Vr = 0.546 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1764.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1764.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0092 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0092 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0092 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112205,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            250.28       749.90       156.53      1083.42       790.23
           ------------------------------------------------------------------------------
            DL+LL+Others      250.28       749.90       156.53      1083.42       790.23
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      156.53 kN-m.
           -. End Moments (My2) =      749.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      749.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      749.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      790.23 kN-m.
          -. End Moments (Mz2) =     1083.42 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1083.42 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1083.42 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       966.532 kN.
          -. Mry        =      2881.809 kN-m.
          -. Mrz        =      4155.103 kN-m.
          -. Mr         =      5056.649 kN-m.
          -. Pu/Pr      =   0.259  --->  O.K !
          -. Muy/Mry    =   0.260  --->  O.K !
          -. Muz/Mrz    =   0.261  --->  O.K !
          -. Mu/Mr      =   0.261  --->  O.K !
          -. Ratio      =   0.261  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        250.28 kN.
          -. Vuz    =       1286.17 kN.
          -. Muy    =        749.90 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        637.71 kN.
          -. Muz    =       1083.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.88
```

( ). Compute shear strength of concrete.
-. Vuz = 1286.17 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1302.86 kN.
-. phiVcz = phi * Vcz = 1172.57 kN.

-. Vuy = 637.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1302.86 kN.
-. phiVcy = phi * Vcy = 1172.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2156.52 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5845.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2156.52 kN.
-. phiVsz = phi*Vsz = 1940.87 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2156.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5845.63 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2156.52 kN.
-. phiVsy = phi*Vsy = 1940.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1435.582 kN.
-. Vr = 3113.442 kN.
-. Ratio = Vu / Vr = 0.461 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1595.09 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1595.09 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0068 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0068 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0068 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112206,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            274.20       156.53       639.77       790.23       557.84
           ------------------------------------------------------------------------------
            DL+LL+Others      274.20       156.53       639.77       790.23       557.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      156.53 kN-m.
           -. End Moments (My2) =      639.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      639.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      639.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      557.84 kN-m.
          -. End Moments (Mz2) =      790.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      557.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      557.84 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1660.658 kN.
          -. Mry        =      3855.175 kN-m.
          -. Mrz        =      3350.521 kN-m.
          -. Mr         =      5107.677 kN-m.
          -. Pu/Pr      =   0.165  --->  O.K !
          -. Muy/Mry    =   0.166  --->  O.K !
          -. Muz/Mrz    =   0.166  --->  O.K !
          -. Mu/Mr      =   0.166  --->  O.K !
          -. Ratio      =   0.166  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2055.46 kN.
          -. Vuz    =       1114.08 kN.
          -. Muy    =       -563.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        487.13 kN.
          -. Muz    =       -352.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 1114.08 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1284.95 kN.
-. phiVcz = phi * Vcz = 1156.46 kN.

-. Vuy = 487.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1242.76 kN.
-. phiVcy = phi * Vcy = 1118.48 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2147.50 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5863.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2147.50 kN.
-. phiVsz = phi*Vsz = 1932.75 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2125.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5905.73 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2125.44 kN.
-. phiVsy = phi*Vsy = 1912.90 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1215.920 kN.
-. Vr = 3031.377 kN.
-. Ratio = Vu / Vr = 0.401 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1351.02 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1351.02 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0013 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0013 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112207,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            286.14       639.77      1105.38       557.84       394.80
           ------------------------------------------------------------------------------
            DL+LL+Others      286.14       639.77      1105.38       557.84       394.80
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      639.77 kN-m.
           -. End Moments (My2) =     1105.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1105.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1105.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      394.80 kN-m.
          -. End Moments (Mz2) =      557.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      394.80 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      394.80 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1225.678 kN.
          -. Mry        =      4776.768 kN-m.
          -. Mrz        =      1705.986 kN-m.
          -. Mr         =      5072.268 kN-m.
          -. Pu/Pr      =   0.233  --->  O.K !
          -. Muy/Mry    =   0.231  --->  O.K !
          -. Muz/Mrz    =   0.231  --->  O.K !
          -. Mu/Mr      =   0.233  --->  O.K !
          -. Ratio      =   0.233  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        286.14 kN.
          -. Vuz    =        999.47 kN.
          -. Muy    =       1105.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.06

          -. Vuy    =        526.59 kN.
          -. Muz    =        394.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.06
```

( ). Compute shear strength of concrete.
-. Vuz = 999.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1384.24 kN.
-. phiVcz = phi * Vcz = 1245.82 kN.

-. Vuy = 526.59 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1384.24 kN.
-. phiVcy = phi * Vcy = 1245.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2195.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5764.25 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2195.20 kN.
-. phiVsz = phi*Vsz = 1975.68 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2195.20 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5764.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2195.20 kN.
-. phiVsy = phi*Vsy = 1975.68 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1129.709 kN.
-. Vr = 3221.494 kN.
-. Ratio = Vu / Vr = 0.351 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1255.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1255.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0056 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0056 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112208,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            298.07      1105.38      1505.51       394.80       353.48
           ------------------------------------------------------------------------------
            DL+LL+Others      298.07      1105.38      1505.51       394.80       353.48
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1105.38 kN-m.
           -. End Moments (My2) =     1505.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1505.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1505.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      353.48 kN-m.
          -. End Moments (Mz2) =      394.80 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      353.48 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      353.48 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       978.842 kN.
          -. Mry        =      4924.999 kN-m.
          -. Mrz        =      1151.820 kN-m.
          -. Mr         =      5057.895 kN-m.
          -. Pu/Pr      =   0.305  --->  O.K !
          -. Muy/Mry    =   0.306  --->  O.K !
          -. Muz/Mrz    =   0.307  --->  O.K !
          -. Mu/Mr      =   0.307  --->  O.K !
          -. Ratio      =   0.307  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        298.07 kN.
          -. Vuz    =        859.42 kN.
          -. Muy    =       1505.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        470.57 kN.
          -. Muz    =        353.48 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 859.42 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1331.63 kN.
-. phiVcz = phi * Vcz = 1198.47 kN.

-. Vuy = 470.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1331.63 kN.
-. phiVcy = phi * Vcy = 1198.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2170.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5816.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2170.62 kN.
-. phiVsz = phi*Vsz = 1953.56 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2170.62 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5816.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2170.62 kN.
-. phiVsy = phi*Vsy = 1953.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 979.812 kN.
-. Vr = 3152.029 kN.
-. Ratio = Vu / Vr = 0.311 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1088.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1088.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0064 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0064 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0064 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112209,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            310.01      1505.51      1840.48       353.48       445.49
           ------------------------------------------------------------------------------
            DL+LL+Others      310.01      1505.51      1840.48       353.48       445.49
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1505.51 kN-m.
           -. End Moments (My2) =     1840.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1840.48 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1840.48 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      353.48 kN-m.
          -. End Moments (Mz2) =      445.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      445.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      445.49 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       824.351 kN.
          -. Mry        =      4903.607 kN-m.
          -. Mrz        =      1187.366 kN-m.
          -. Mr         =      5045.315 kN-m.
          -. Pu/Pr      =   0.376  --->  O.K !
          -. Muy/Mry    =   0.375  --->  O.K !
          -. Muz/Mrz    =   0.375  --->  O.K !
          -. Mu/Mr      =   0.376  --->  O.K !
          -. Ratio      =   0.376  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        310.01 kN.
          -. Vuz    =        723.81 kN.
          -. Muy    =       1840.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.20 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.85

          -. Vuy    =        415.26 kN.
          -. Muz    =        445.49 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.20 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.85
```

( ). Compute shear strength of concrete.
-. Vuz = 723.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1286.97 kN.
-. phiVcz = phi * Vcz = 1158.27 kN.

-. Vuy = 415.26 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1286.97 kN.
-. phiVcy = phi * Vcy = 1158.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2148.53 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5861.52 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2148.53 kN.
-. phiVsz = phi*Vsz = 1933.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2148.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5861.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2148.53 kN.
-. phiVsy = phi*Vsy = 1933.67 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 834.472 kN.
-. Vr = 3091.947 kN.
-. Ratio = Vu / Vr = 0.270 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 927.19 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 927.19 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0072 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0072 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0072 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112210,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            321.95      1840.48      2112.97       445.49       554.87
           ---------------------------------------------------------------------------
            DL+LL+Others      321.95      1840.48      2112.97       445.49       554.87
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1840.48 kN-m.
           -. End Moments (My2) =     2112.97 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2112.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2112.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      445.49 kN-m.
          -. End Moments (Mz2) =      554.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      554.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      554.87 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       740.371 kN.
          -. Mry        =      4872.795 kN-m.
          -. Mrz        =      1278.126 kN-m.
          -. Mr         =      5037.632 kN-m.
          -. Pu/Pr      =   0.435  --->  O.K !
          -. Muy/Mry    =   0.434  --->  O.K !
          -. Muz/Mrz    =   0.434  --->  O.K !
          -. Mu/Mr      =   0.435  --->  O.K !
          -. Ratio      =   0.435  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        321.95 kN.
          -. Vuz    =        594.31 kN.
          -. Muy    =       2112.97 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        361.43 kN.
          -. Muz    =        554.87 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.78
```

( ). Compute shear strength of concrete.
-. Vuz = 594.31 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1254.29 kN.
-. phiVcz = phi * Vcz = 1128.86 kN.

-. Vuy = 361.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1254.29 kN.
-. phiVcy = phi * Vcy = 1128.86 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2131.59 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5894.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2131.59 kN.
-. phiVsz = phi*Vsz = 1918.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2131.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5894.19 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2131.59 kN.
-. phiVsy = phi*Vsy = 1918.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 695.587 kN.
-. Vr = 3047.290 kN.
-. Ratio = Vu / Vr = 0.228 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 772.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 772.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0077 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0077 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0077 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112211,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            333.89      2112.97      2327.70       554.87       654.09
           ---------------------------------------------------------------------------
            DL+LL+Others      333.89      2112.97      2327.70       554.87       654.09
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2112.97 kN-m.
           -. End Moments (My2) =     2327.70 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2327.70 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2327.70 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      554.87 kN-m.
          -. End Moments (Mz2) =      654.09 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      654.09 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      654.09 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       696.253 kN.
          -. Mry        =      4847.689 kN-m.
          -. Mrz        =      1358.665 kN-m.
          -. Mr         =      5034.487 kN-m.
          -. Pu/Pr      =   0.480  --->  O.K !
          -. Muy/Mry    =   0.480  --->  O.K !
          -. Muz/Mrz    =   0.481  --->  O.K !
          -. Mu/Mr      =   0.481  --->  O.K !
          -. Ratio      =   0.481  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        333.89 kN.
          -. Vuz    =        472.53 kN.
          -. Muy    =       2327.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73

          -. Vuy    =        309.76 kN.
          -. Muz    =        654.09 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.55 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.73
```

( ). Compute shear strength of concrete.
-. Vuz = 472.53 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1231.99 kN.
-. phiVcz = phi * Vcz = 1108.79 kN.

-. Vuy = 309.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1231.99 kN.
-. phiVcy = phi * Vcy = 1108.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2119.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5916.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2119.62 kN.
-. phiVsz = phi*Vsz = 1907.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2119.62 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5916.50 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2119.62 kN.
-. phiVsy = phi*Vsy = 1907.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 565.013 kN.
-. Vr = 3016.450 kN.
-. Ratio = Vu / Vr = 0.187 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 627.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 627.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0082 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0082 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0082 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112212,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            345.83      2327.70      2490.41       654.09       739.60
           ------------------------------------------------------------------------------
            DL+LL+Others      345.83      2327.70      2490.41       654.09       739.60
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2327.70 kN-m.
           -. End Moments (My2) =     2490.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2490.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2490.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      654.09 kN-m.
          -. End Moments (Mz2) =      739.60 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      739.60 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      739.60 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       676.478 kN.
          -. Mry        =      4824.901 kN-m.
          -. Mrz        =      1430.574 kN-m.
          -. Mr         =      5032.516 kN-m.
          -. Pu/Pr      =   0.511  --->  O.K !
          -. Muy/Mry    =   0.516  --->  O.K !
          -. Muz/Mrz    =   0.517  --->  O.K !
          -. Mu/Mr      =   0.517  --->  O.K !
          -. Ratio      =   0.517  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        345.83 kN.
          -. Vuz    =        360.00 kN.
          -. Muy    =       2490.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =        261.00 kN.
          -. Muz    =        739.60 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.70
```

( ). Compute shear strength of concrete.
-. Vuz = 360.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1217.98 kN.
-. phiVcz = phi * Vcz = 1096.18 kN.

-. Vuy = 261.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1217.98 kN.
-. phiVcy = phi * Vcy = 1096.18 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2111.94 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5930.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2111.94 kN.
-. phiVsz = phi*Vsz = 1900.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2111.94 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5930.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2111.94 kN.
-. phiVsy = phi*Vsy = 1900.74 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 444.657 kN.
-. Vr = 2996.923 kN.
-. Ratio = Vu / Vr = 0.148 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 494.06 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 494.06 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0085 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0085 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0085 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112213,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            357.78      2490.41      2585.18       739.60       803.57
           ------------------------------------------------------------------------------
            DL+LL+Others      357.78      2490.41      2585.18       739.60       803.57
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2490.41 kN-m.
           -. End Moments (My2) =     2585.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2585.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2585.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      739.60 kN-m.
          -. End Moments (Mz2) =      803.57 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      803.57 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      803.57 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       668.876 kN.
          -. Mry        =      4805.105 kN-m.
          -. Mrz        =      1492.788 kN-m.
          -. Mr         =      5031.645 kN-m.
          -. Pu/Pr      =   0.535  --->  O.K !
          -. Muy/Mry    =   0.538  --->  O.K !
          -. Muz/Mrz    =   0.538  --->  O.K !
          -. Mu/Mr      =   0.538  --->  O.K !
          -. Ratio      =   0.538  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        357.78 kN.
          -. Vuz    =        212.44 kN.
          -. Muy    =       2585.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =        195.75 kN.
          -. Muz    =        803.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.70
```

( ). Compute shear strength of concrete.
-. Vuz = 212.44 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1221.42 kN.
-. phiVcz = phi * Vcz = 1099.28 kN.

-. Vuy = 195.75 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1221.42 kN.
-. phiVcy = phi * Vcy = 1099.28 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2113.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5927.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2113.84 kN.
-. phiVsz = phi*Vsz = 1902.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2113.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5927.06 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2113.84 kN.
-. phiVsy = phi*Vsy = 1902.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 288.882 kN.
-. Vr = 3001.737 kN.
-. Ratio = Vu / Vr = 0.096 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 320.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 320.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0084 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0084 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0084 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112214,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            369.72      2585.18      2599.39       803.57       839.30
           ---------------------------------------------------------------------------
            DL+LL+Others      369.72      2585.18      2599.39       803.57       839.30
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2585.18 kN-m.
           -. End Moments (My2) =     2599.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2599.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2599.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      803.57 kN-m.
          -. End Moments (Mz2) =      839.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      839.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      839.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       681.585 kN.
          -. Mry        =      4788.818 kN-m.
          -. Mrz        =      1547.211 kN-m.
          -. Mr         =      5032.558 kN-m.
          -. Pu/Pr      =   0.542  --->  O.K !
          -. Muy/Mry    =   0.543  --->  O.K !
          -. Muz/Mrz    =   0.542  --->  O.K !
          -. Mu/Mr      =   0.543  --->  O.K !
          -. Ratio      =   0.543  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        369.72 kN.
          -. Vuz    =         45.85 kN.
          -. Muy    =       2599.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =        121.52 kN.
          -. Muz    =        839.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 45.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1240.21 kN.
-. phiVcz = phi * Vcz = 1116.19 kN.

-. Vuy = 121.52 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1240.21 kN.
-. phiVcy = phi * Vcy = 1116.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2124.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5908.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2124.07 kN.
-. phiVsz = phi*Vsz = 1911.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2124.07 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5908.28 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2124.07 kN.
-. phiVsy = phi*Vsy = 1911.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 129.885 kN.
-. Vr = 3027.847 kN.
-. Ratio = Vu / Vr = 0.043 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 144.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 144.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0082 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0082 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0082 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112215,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            369.68      2599.39      2543.60       839.30       846.86
           ------------------------------------------------------------------------------
            DL+LL+Others      369.68      2599.39      2543.60       839.30       846.86
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2543.60 kN-m.
           -. End Moments (My2) =     2599.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2599.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2599.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      839.30 kN-m.
          -. End Moments (Mz2) =      846.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      839.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      839.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       681.585 kN.
          -. Mry        =      4788.818 kN-m.
          -. Mrz        =      1547.211 kN-m.
          -. Mr         =      5032.558 kN-m.
          -. Pu/Pr      =   0.542  --->  O.K !
          -. Muy/Mry    =   0.543  --->  O.K !
          -. Muz/Mrz    =   0.542  --->  O.K !
          -. Mu/Mr      =   0.543  --->  O.K !
          -. Ratio      =   0.543  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        369.68 kN.
          -. Vuz    =        122.10 kN.
          -. Muy    =       2599.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =         68.63 kN.
          -. Muz    =        839.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 122.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1238.66 kN.
-. phiVcz = phi * Vcz = 1114.79 kN.

-. Vuy = 68.63 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1238.66 kN.
-. phiVcy = phi * Vcy = 1114.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2123.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5909.83 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2123.23 kN.
-. phiVsz = phi*Vsz = 1910.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5909.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.23 kN.
-. phiVsy = phi*Vsy = 1910.91 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 140.063 kN.
-. Vr = 3025.702 kN.
-. Ratio = Vu / Vr = 0.046 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 155.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 155.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0082 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0082 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0082 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112216,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            381.63      2543.60      2430.99       846.86       830.60
           ------------------------------------------------------------------------------
            DL+LL+Others      381.63      2543.60      2430.99       846.86       830.60
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2430.99 kN-m.
           -. End Moments (My2) =     2543.60 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2543.60 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2543.60 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      830.60 kN-m.
          -. End Moments (Mz2) =      846.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      846.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      846.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       722.258 kN.
          -. Mry        =      4777.158 kN-m.
          -. Mrz        =      1593.446 kN-m.
          -. Mr         =      5035.901 kN-m.
          -. Pu/Pr      =   0.528  --->  O.K !
          -. Muy/Mry    =   0.532  --->  O.K !
          -. Muz/Mrz    =   0.531  --->  O.K !
          -. Mu/Mr      =   0.532  --->  O.K !
          -. Ratio      =   0.532  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2205.86 kN.
          -. Vuz    =        225.25 kN.
          -. Muy    =      -2555.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.54

          -. Vuy    =         36.49 kN.
          -. Muz    =       -916.63 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.45
```

( ). Compute shear strength of concrete.
-. Vuz = 225.25 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1147.94 kN.
-. phiVcz = phi * Vcz = 1033.14 kN.

-. Vuy = 36.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1104.61 kN.
-. phiVcy = phi * Vcy = 994.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2071.35 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6000.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2071.35 kN.
-. phiVsz = phi*Vsz = 1864.22 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2044.30 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6043.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2044.30 kN.
-. phiVsy = phi*Vsy = 1839.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 228.190 kN.
-. Vr = 2834.022 kN.
-. Ratio = Vu / Vr = 0.081 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 253.54 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 253.54 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0053 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0054 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0054 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112217,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            393.58      2430.99      2274.33       830.60       794.74
           ------------------------------------------------------------------------------
            DL+LL+Others      393.58      2430.99      2274.33       830.60       794.74
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2274.33 kN-m.
           -. End Moments (My2) =     2430.99 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2430.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2430.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      794.74 kN-m.
          -. End Moments (Mz2) =      830.60 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      830.60 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      830.60 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       769.129 kN.
          -. Mry        =      4767.691 kN-m.
          -. Mrz        =      1633.648 kN-m.
          -. Mr         =      5039.810 kN-m.
          -. Pu/Pr      =   0.512  --->  O.K !
          -. Muy/Mry    =   0.510  --->  O.K !
          -. Muz/Mrz    =   0.508  --->  O.K !
          -. Mu/Mr      =   0.512  --->  O.K !
          -. Ratio      =   0.512  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2222.55 kN.
          -. Vuz    =        312.75 kN.
          -. Muy    =      -2446.25 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.55

          -. Vuy    =         71.31 kN.
          -. Muz    =       -909.06 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.47 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.45
```

( ). Compute shear strength of concrete.
-. Vuz = 312.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1150.41 kN.
-. phiVcz = phi * Vcz = 1035.37 kN.

-. Vuy = 71.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1107.10 kN.
-. phiVcy = phi * Vcy = 996.39 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2072.85 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5998.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2072.85 kN.
-. phiVsz = phi*Vsz = 1865.57 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2045.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6041.39 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2045.89 kN.
-. phiVsy = phi*Vsy = 1841.30 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 320.773 kN.
-. Vr = 2837.692 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 356.41 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 356.41 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112218,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            405.54      2274.33      2086.31       794.74       743.87
           ------------------------------------------------------------------------------
            DL+LL+Others      405.54      2274.33      2086.31       794.74       743.87
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2086.31 kN-m.
           -. End Moments (My2) =     2274.33 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2274.33 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2274.33 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      743.87 kN-m.
          -. End Moments (Mz2) =      794.74 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      794.74 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      794.74 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       848.830 kN.
          -. Mry        =      4762.006 kN-m.
          -. Mrz        =      1670.512 kN-m.
          -. Mr         =      5046.515 kN-m.
          -. Pu/Pr      =   0.478  --->  O.K !
          -. Muy/Mry    =   0.478  --->  O.K !
          -. Muz/Mrz    =   0.476  --->  O.K !
          -. Mu/Mr      =   0.478  --->  O.K !
          -. Ratio      =   0.478  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2239.25 kN.
          -. Vuz    =        375.15 kN.
          -. Muy    =      -2292.09 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.57

          -. Vuy    =        103.35 kN.
          -. Muz    =       -877.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.37 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48
```

( ). Compute shear strength of concrete.
-. Vuz = 375.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1163.04 kN.
-. phiVcz = phi * Vcz = 1046.74 kN.

-. Vuy = 103.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1119.78 kN.
-. phiVcy = phi * Vcy = 1007.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2080.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5985.44 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2080.42 kN.
-. phiVsz = phi*Vsz = 1872.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2053.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6028.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2053.95 kN.
-. phiVsy = phi*Vsy = 1848.55 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 389.122 kN.
-. Vr = 2856.352 kN.
-. Ratio = Vu / Vr = 0.136 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 432.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 432.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0048 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112219,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            417.50      2086.31      1878.90       743.87       682.45
           ------------------------------------------------------------------------------
            DL+LL+Others      417.50      2086.31      1878.90       743.87       682.45
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1878.90 kN-m.
           -. End Moments (My2) =     2086.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2086.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2086.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      682.45 kN-m.
          -. End Moments (Mz2) =      743.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      743.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      743.87 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       950.288 kN.
          -. Mry        =      4758.851 kN-m.
          -. Mrz        =      1704.944 kN-m.
          -. Mr         =      5055.047 kN-m.
          -. Pu/Pr      =   0.439  --->  O.K !
          -. Muy/Mry    =   0.438  --->  O.K !
          -. Muz/Mrz    =   0.436  --->  O.K !
          -. Mu/Mr      =   0.439  --->  O.K !
          -. Ratio      =   0.439  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2255.94 kN.
          -. Vuz    =        414.30 kN.
          -. Muy    =      -2105.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62

          -. Vuy    =        127.55 kN.
          -. Muz    =       -828.23 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.20 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53
```

```
( ). Compute shear strength of concrete.
     -. Vuz       =      414.30 kN.
     -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1184.43 kN.
     -. phiVcz    = phi * Vcz =     1065.99 kN.

     -. Vuy       =      127.55 kN.
     -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1141.27 kN.
     -. phiVcy    = phi * Vcy =     1027.14 kN.

( ). Compute maximum spacing of ties.
     -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
     -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
     -. Applied spacing s_z   =    0.150 m.

     -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
     -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
     -. Applied spacing s_y   =    0.150 m.

     -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

( ). Compute shear strength of reinforcement.
     -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2092.96 kN.
     -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5964.05 kN.
     -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2092.96 kN.
     -. phiVsz   = phi*Vsz =     1883.66 kN.
     -. phiVsz > (Vuz-phiVcz)  --->  O.K !
     -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

     -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2067.29 kN.
     -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6007.21 kN.
     -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2067.29 kN.
     -. phiVsy   = phi*Vsy =     1860.56 kN.
     -. phiVsy > (Vuy-phiVcy)  --->  O.K !
     -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

     -. Vu       =     433.488 kN.
     -. Vr       =    2887.708 kN.
     -. Ratio    = Vu / Vr = 0.150  --->  O.K !

( ). Compute minimum longitudinal reinforcement by shear.
     -. phia     =   0.75
     -. phib     =   0.90
     -. phiv     =   0.90
     -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =      481.65 kN.
     -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =      481.65 kN.
     -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy =
0.0043 m^2.
     -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy =
0.0043 m^2.
     -. As_req  =  MAX[ Asy_req, Asz_req ] =   0.0043 m^2.
     -. As      =   0.0363 m^2.
     -. As_req < As  --->  O.K !
```

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112220,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            429.45      1878.90      1663.04       682.45       614.62
           ------------------------------------------------------------------------------
            DL+LL+Others      429.45      1878.90      1663.04       682.45       614.62
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1663.04 kN-m.
           -. End Moments (My2) =     1878.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1878.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1878.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      614.62 kN-m.
          -. End Moments (Mz2) =      682.45 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      682.45 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      682.45 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1087.091 kN.
          -. Mry        =      4758.956 kN-m.
          -. Mrz        =      1738.317 kN-m.
          -. Mr         =      5066.498 kN-m.
          -. Pu/Pr      =   0.395  --->  O.K !
          -. Muy/Mry    =   0.395  --->  O.K !
          -. Muz/Mrz    =   0.393  --->  O.K !
          -. Mu/Mr      =   0.395  --->  O.K !
          -. Ratio      =   0.395  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2272.63 kN.
          -. Vuz    =        432.32 kN.
          -. Muy    =      -1898.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.67 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.69

          -. Vuy    =        143.88 kN.
          -. Muz    =       -765.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.98 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.59
```

( ). Compute shear strength of concrete.
-. Vuz = 432.32 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1213.27 kN.
-. phiVcz = phi * Vcz = 1091.95 kN.

-. Vuy = 143.88 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1170.31 kN.
-. phiVcy = phi * Vcy = 1053.28 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2109.32 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5935.21 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2109.32 kN.
-. phiVsz = phi*Vsz = 1898.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2084.72 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5978.18 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2084.72 kN.
-. phiVsy = phi*Vsy = 1876.25 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 455.632 kN.
-. Vr = 2929.528 kN.
-. Ratio = Vu / Vr = 0.156 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 506.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 506.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112221,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            441.41      1663.04      1448.45       614.62       544.13
           ------------------------------------------------------------------------------
            DL+LL+Others      441.41      1663.04      1448.45       614.62       544.13
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1448.45 kN-m.
           -. End Moments (My2) =     1663.04 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1663.04 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1663.04 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      544.13 kN-m.
          -. End Moments (Mz2) =      614.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      614.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      614.62 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1251.769 kN.
          -. Mry        =      4759.672 kN-m.
          -. Mrz        =      1759.180 kN-m.
          -. Mr         =      5074.366 kN-m.
          -. Pu/Pr      =   0.353  --->  O.K !
          -. Muy/Mry    =   0.349  --->  O.K !
          -. Muz/Mrz    =   0.349  --->  O.K !
          -. Mu/Mr      =   0.353  --->  O.K !
          -. Ratio      =   0.353  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2289.32 kN.
          -. Vuz    =        430.86 kN.
          -. Muy    =      -1682.55 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.76

          -. Vuy    =        152.17 kN.
          -. Muz    =       -693.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.73 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67
```

( ). Compute shear strength of concrete.
-. Vuz = 430.86 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1248.43 kN.
-. phiVcz = phi * Vcz = 1123.59 kN.

-. Vuy = 152.17 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1205.80 kN.
-. phiVcy = phi * Vcy = 1085.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2128.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5900.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2128.47 kN.
-. phiVsz = phi*Vsz = 1915.63 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2105.14 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5942.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2105.14 kN.
-. phiVsy = phi*Vsy = 1894.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 456.944 kN.
-. Vr = 2979.840 kN.
-. Ratio = Vu / Vr = 0.153 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 507.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 507.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112222,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2306.00     -1467.14     -1260.92      -617.63      -541.24
           ------------------------------------------------------------------------------
            DL+LL+Others     2306.00     -1467.14     -1260.92      -617.63      -541.24
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1260.92 kN-m.
           -. End Moments (My2) =     1467.14 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1467.14 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1467.14 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      541.24 kN-m.
          -. End Moments (Mz2) =      617.63 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -617.63 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -617.63 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7421.890 kN.
          -. Mry        =      4714.234 kN-m.
          -. Mrz        =      1986.830 kN-m.
          -. Mr         =      5115.808 kN-m.
          -. Pu/Pr      =   0.311  --->  O.K !
          -. Muy/Mry    =   0.311  --->  O.K !
          -. Muz/Mrz    =   0.311  --->  O.K !
          -. Mu/Mr      =   0.311  --->  O.K !
          -. Ratio      =   0.311  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2306.00 kN.
          -. Vuz    =        412.46 kN.
          -. Muy    =      -1467.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.85

          -. Vuy    =        152.96 kN.
          -. Muz    =       -617.63 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.45 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 412.46 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1288.63 kN.
-. phiVcz = phi * Vcz = 1159.77 kN.

-. Vuy = 152.96 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1246.49 kN.
-. phiVcy = phi * Vcy = 1121.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2149.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5859.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2149.37 kN.
-. phiVsz = phi*Vsz = 1934.44 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2127.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5902.00 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2127.44 kN.
-. phiVsy = phi*Vsy = 1914.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 439.912 kN.
-. Vr = 3036.530 kN.
-. Ratio = Vu / Vr = 0.145 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 488.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 488.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112223,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2322.68     -1260.92     -1070.17      -541.24      -467.58
           ------------------------------------------------------------------------------
            DL+LL+Others     2322.68     -1260.92     -1070.17      -541.24      -467.58
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1070.17 kN-m.
           -. End Moments (My2) =     1260.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1260.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1260.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      467.58 kN-m.
          -. End Moments (Mz2) =      541.24 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -541.24 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -541.24 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8499.915 kN.
          -. Mry        =      4586.208 kN-m.
          -. Mrz        =      1970.463 kN-m.
          -. Mr         =      4991.595 kN-m.
          -. Pu/Pr      =   0.273  --->  O.K !
          -. Muy/Mry    =   0.275  --->  O.K !
          -. Muz/Mrz    =   0.275  --->  O.K !
          -. Mu/Mr      =   0.275  --->  O.K !
          -. Ratio      =   0.275  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2322.68 kN.
          -. Vuz    =        381.51 kN.
          -. Muy    =      -1260.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        147.44 kN.
          -. Muz    =       -541.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86
```

( ). Compute shear strength of concrete.
-. Vuz = 381.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1332.19 kN.
-. phiVcz = phi * Vcz = 1198.97 kN.

-. Vuy = 147.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1290.71 kN.
-. phiVcy = phi * Vcy = 1161.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2170.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5816.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2170.89 kN.
-. phiVsz = phi*Vsz = 1953.80 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2150.42 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5857.78 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2150.42 kN.
-. phiVsy = phi*Vsy = 1935.38 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 409.008 kN.
-. Vr = 3097.018 kN.
-. Ratio = Vu / Vr = 0.132 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 454.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 454.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112224,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2339.37     -1070.17      -894.16      -467.58      -397.69
           ------------------------------------------------------------------------------
            DL+LL+Others     2339.37     -1070.17      -894.16      -467.58      -397.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      894.16 kN-m.
           -. End Moments (My2) =     1070.17 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1070.17 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1070.17 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      397.69 kN-m.
          -. End Moments (Mz2) =      467.58 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -467.58 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -467.58 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9665.407 kN.
          -. Mry        =      4457.908 kN-m.
          -. Mrz        =      1938.475 kN-m.
          -. Mr         =      4861.135 kN-m.
          -. Pu/Pr      =   0.242  --->  O.K !
          -. Muy/Mry    =   0.240  --->  O.K !
          -. Muz/Mrz    =   0.241  --->  O.K !
          -. Mu/Mr      =   0.242  --->  O.K !
          -. Ratio      =   0.242  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2339.37 kN.
          -. Vuz    =        352.02 kN.
          -. Muy    =      -1070.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        139.85 kN.
          -. Muz    =       -467.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 352.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1375.59 kN.
-. phiVcz = phi * Vcz = 1238.03 kN.

-. Vuy = 139.85 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1334.91 kN.
-. phiVcy = phi * Vcy = 1201.42 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2191.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5772.90 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2191.26 kN.
-. phiVsz = phi*Vsz = 1972.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2172.20 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5813.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2172.20 kN.
-. phiVsy = phi*Vsy = 1954.98 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 378.783 kN.
-. Vr = 3156.399 kN.
-. Ratio = Vu / Vr = 0.120 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 420.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 420.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112225,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2356.05      -894.16      -735.25      -397.69      -332.91
           ------------------------------------------------------------------------------
            DL+LL+Others     2356.05      -894.16      -735.25      -397.69      -332.91
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      735.25 kN-m.
           -. End Moments (My2) =      894.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -894.16 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -894.16 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      332.91 kN-m.
          -. End Moments (Mz2) =      397.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -397.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -397.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11313.895 kN.
          -. Mry        =      4301.305 kN-m.
          -. Mrz        =      1917.692 kN-m.
          -. Mr         =      4709.434 kN-m.
          -. Pu/Pr      =   0.208  --->  O.K !
          -. Muy/Mry    =   0.208  --->  O.K !
          -. Muz/Mrz    =   0.207  --->  O.K !
          -. Mu/Mr      =   0.208  --->  O.K !
          -. Ratio      =   0.208  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2356.05 kN.
          -. Vuz    =        317.83 kN.
          -. Muy    =       -894.16 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.14

          -. Vuy    =        129.63 kN.
          -. Muz    =       -397.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.67 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.05
```

( ). Compute shear strength of concrete.
-. Vuz = 317.83 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1419.66 kN.
-. phiVcz = phi * Vcz = 1277.70 kN.

-. Vuy = 129.63 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1379.95 kN.
-. phiVcy = phi * Vcy = 1241.95 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2210.93 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5728.82 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2210.93 kN.
-. phiVsz = phi*Vsz = 1989.83 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2193.25 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5768.54 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2193.25 kN.
-. phiVsy = phi*Vsy = 1973.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 343.253 kN.
-. Vr = 3215.878 kN.
-. Ratio = Vu / Vr = 0.107 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 381.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 381.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-7.3175e-006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-1.2939e-006 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-1.2939e-006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112226,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2372.72      -735.25      -594.81      -332.91      -274.13
           ------------------------------------------------------------------------------
            DL+LL+Others     2372.72      -735.25      -594.81      -332.91      -274.13
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      594.81 kN-m.
           -. End Moments (My2) =      735.25 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -735.25 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -735.25 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      274.13 kN-m.
          -. End Moments (Mz2) =      332.91 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -332.91 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -332.91 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     13317.399 kN.
          -. Mry        =      4101.922 kN-m.
          -. Mrz        =      1850.646 kN-m.
          -. Mr         =      4500.073 kN-m.
          -. Pu/Pr      =   0.178  --->  O.K !
          -. Muy/Mry    =   0.179  --->  O.K !
          -. Muz/Mrz    =   0.180  --->  O.K !
          -. Mu/Mr      =   0.180  --->  O.K !
          -. Ratio      =   0.180  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2372.72 kN.
          -. Vuz    =        280.89 kN.
          -. Muy    =       -735.25 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.25 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.24

          -. Vuy    =        117.61 kN.
          -. Muz    =       -332.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.15
```

( ). Compute shear strength of concrete.
-. Vuz = 280.89 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1463.25 kN.
-. phiVcz = phi * Vcz = 1316.92 kN.

-. Vuy = 117.61 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1424.63 kN.
-. phiVcy = phi * Vcy = 1282.17 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2229.44 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5685.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2229.44 kN.
-. phiVsz = phi*Vsz = 2006.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2213.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5723.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2213.08 kN.
-. phiVsy = phi*Vsy = 1991.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 304.515 kN.
-. Vr = 3273.946 kN.
-. Ratio = Vu / Vr = 0.093 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 338.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 338.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112227,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2389.40      -594.81      -472.27      -274.13      -221.50
           ------------------------------------------------------------------------------
            DL+LL+Others     2389.40      -594.81      -472.27      -274.13      -221.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      472.27 kN-m.
           -. End Moments (My2) =      594.81 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -594.81 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -594.81 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      221.50 kN-m.
          -. End Moments (Mz2) =      274.13 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -274.13 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -274.13 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15367.177 kN.
          -. Mry        =      3848.176 kN-m.
          -. Mrz        =      1777.162 kN-m.
          -. Mr         =      4238.722 kN-m.
          -. Pu/Pr      =   0.155  --->  O.K !
          -. Muy/Mry    =   0.155  --->  O.K !
          -. Muz/Mrz    =   0.154  --->  O.K !
          -. Mu/Mr      =   0.155  --->  O.K !
          -. Ratio      =   0.155  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2389.40 kN.
          -. Vuz    =        245.08 kN.
          -. Muy    =       -594.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.33

          -. Vuy    =        105.30 kN.
          -. Muz    =       -274.13 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 245.08 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1504.73 kN.
-. phiVcz = phi * Vcz = 1354.26 kN.

-. Vuy = 105.30 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1467.30 kN.
-. phiVcy = phi * Vcy = 1320.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2246.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5643.76 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2246.26 kN.
-. phiVsz = phi*Vsz = 2021.64 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2231.12 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5681.19 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2231.12 kN.
-. phiVsy = phi*Vsy = 2008.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 266.744 kN.
-. Vr = 3328.578 kN.
-. Ratio = Vu / Vr = 0.080 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 296.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 296.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112228,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2406.07      -472.27      -361.71      -221.50      -173.16
           ------------------------------------------------------------------------------
            DL+LL+Others     2406.07      -472.27      -361.71      -221.50      -173.16
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      361.71 kN-m.
           -. End Moments (My2) =      472.27 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -472.27 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -472.27 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      173.16 kN-m.
          -. End Moments (Mz2) =      221.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -221.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -221.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17773.360 kN.
          -. Mry        =      3492.140 kN-m.
          -. Mrz        =      1632.058 kN-m.
          -. Mr         =      3854.692 kN-m.
          -. Pu/Pr      =   0.135  --->  O.K !
          -. Muy/Mry    =   0.135  --->  O.K !
          -. Muz/Mrz    =   0.136  --->  O.K !
          -. Mu/Mr      =   0.136  --->  O.K !
          -. Ratio      =   0.136  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2406.07 kN.
          -. Vuz    =        221.13 kN.
          -. Muy    =       -472.27 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.41

          -. Vuy    =         96.71 kN.
          -. Muz    =       -221.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.33
```

( ). Compute shear strength of concrete.
-. Vuz = 221.13 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1541.15 kN.
-. phiVcz = phi * Vcz = 1387.04 kN.

-. Vuy = 96.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1504.87 kN.
-. phiVcy = phi * Vcy = 1354.38 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2260.43 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5607.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2260.43 kN.
-. phiVsz = phi*Vsz = 2034.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2246.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5643.62 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2246.32 kN.
-. phiVsy = phi*Vsy = 2021.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 241.351 kN.
-. Vr = 3376.069 kN.
-. Ratio = Vu / Vr = 0.071 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 268.17 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 268.17 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112229,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2422.74      -361.71      -262.44      -173.16      -129.01
           ------------------------------------------------------------------------------
            DL+LL+Others     2422.74      -361.71      -262.44      -173.16      -129.01
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      262.44 kN-m.
           -. End Moments (My2) =      361.71 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -361.71 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -361.71 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      129.01 kN-m.
          -. End Moments (Mz2) =      173.16 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -173.16 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -173.16 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     20224.337 kN.
          -. Mry        =      3028.106 kN-m.
          -. Mrz        =      1445.962 kN-m.
          -. Mr         =      3355.627 kN-m.
          -. Pu/Pr      =   0.120  --->  O.K !
          -. Muy/Mry    =   0.119  --->  O.K !
          -. Muz/Mrz    =   0.120  --->  O.K !
          -. Mu/Mr      =   0.120  --->  O.K !
          -. Ratio      =   0.120  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2422.74 kN.
          -. Vuz    =        198.55 kN.
          -. Muy    =       -361.71 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.49

          -. Vuy    =         88.33 kN.
          -. Muz    =       -173.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.90 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.41
```

( ). Compute shear strength of concrete.
-. Vuz = 198.55 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1575.72 kN.
-. phiVcz = phi * Vcz = 1418.15 kN.

-. Vuy = 88.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1540.62 kN.
-. phiVcy = phi * Vcy = 1386.56 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2273.38 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5572.77 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2273.38 kN.
-. phiVsz = phi*Vsz = 2046.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2260.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5607.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2260.23 kN.
-. phiVsy = phi*Vsy = 2034.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 217.314 kN.
-. Vr = 3420.762 kN.
-. Ratio = Vu / Vr = 0.064 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 241.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 241.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112230,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2707.16      -174.20      -115.32      -120.96       -82.08
           ------------------------------------------------------------------------------
            DL+LL+Others     2707.16      -174.20      -115.32      -120.96       -82.08
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      115.32 kN-m.
           -. End Moments (My2) =      174.20 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -115.32 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -115.32 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       82.08 kN-m.
          -. End Moments (Mz2) =      120.96 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -82.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -82.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =      1039.755 kN-m.
           -. Mrz        =       739.651 kN-m.
           -. Mr         =      1276.000 kN-m.
           -. Pu/Pr      =   0.111  --->  O.K !
           -. Muy/Mry    =   0.111  --->  O.K !
           -. Muz/Mrz    =   0.111  --->  O.K !
           -. Mu/Mr      =   0.111  --->  O.K !
           -. Ratio      =   0.111  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2439.41 kN.
           -. Vuz    =        177.93 kN.
           -. Muy    =       -262.44 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  30.63 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.56

           -. Vuy    =         80.44 kN.
           -. Muz    =       -129.01 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  30.76 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.48
```

( ). Compute shear strength of concrete.
-. Vuz = 177.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1608.09 kN.
-. phiVcz = phi * Vcz = 1447.28 kN.

-. Vuy = 80.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1574.19 kN.
-. phiVcy = phi * Vcy = 1416.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2285.10 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5540.39 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2285.10 kN.
-. phiVsz = phi*Vsz = 2056.59 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2272.82 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5574.30 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2272.82 kN.
-. phiVsy = phi*Vsy = 2045.53 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 195.271 kN.
-. Vr = 3462.305 kN.
-. Ratio = Vu / Vr = 0.056 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 216.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 216.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112231,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2723.84      -115.32       -68.15       -82.08       -50.37
           ------------------------------------------------------------------------------
            DL+LL+Others     2723.84      -115.32       -68.15       -82.08       -50.37
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       68.15 kN-m.
           -. End Moments (My2) =      115.32 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -68.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -68.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       50.37 kN-m.
          -. End Moments (Mz2) =       82.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -50.37 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -50.37 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       610.481 kN-m.
          -. Mrz        =       451.445 kN-m.
          -. Mr         =       759.270 kN-m.
          -. Pu/Pr      =   0.112  --->  O.K !
          -. Muy/Mry    =   0.112  --->  O.K !
          -. Muz/Mrz    =   0.112  --->  O.K !
          -. Mu/Mr      =   0.112  --->  O.K !
          -. Ratio      =   0.112  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2456.08 kN.
          -. Vuz    =        142.41 kN.
          -. Muy    =       -173.47 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =         66.41 kN.
          -. Muz    =        -88.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.56
```

( ). Compute shear strength of concrete.
-. Vuz = 142.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1642.65 kN.
-. phiVcz = phi * Vcz = 1478.38 kN.

-. Vuy = 66.41 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1610.11 kN.
-. phiVcy = phi * Vcy = 1449.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2297.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5505.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2297.19 kN.
-. phiVsz = phi*Vsz = 2067.47 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2285.81 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5538.38 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2285.81 kN.
-. phiVsy = phi*Vsy = 2057.23 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 157.131 kN.
-. Vr = 3506.328 kN.
-. Ratio = Vu / Vr = 0.045 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 174.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 174.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112232,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2740.51       -68.15       -35.82       -50.37       -27.93
           ------------------------------------------------------------------------------
            DL+LL+Others     2740.51       -68.15       -35.82       -50.37       -27.93
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       35.82 kN-m.
           -. End Moments (My2) =       68.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -35.82 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -35.82 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       27.93 kN-m.
          -. End Moments (Mz2) =       50.37 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -27.93 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -27.93 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       318.755 kN-m.
          -. Mrz        =       248.998 kN-m.
          -. Mr         =       404.481 kN-m.
          -. Pu/Pr      =   0.112  --->  O.K !
          -. Muy/Mry    =   0.112  --->  O.K !
          -. Muz/Mrz    =   0.112  --->  O.K !
          -. Mu/Mr      =   0.112  --->  O.K !
          -. Ratio      =   0.112  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2472.75 kN.
          -. Vuz    =         97.43 kN.
          -. Muy    =       -102.27 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.71

          -. Vuy    =         48.01 kN.
          -. Muz    =        -55.63 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.64
```

( ). Compute shear strength of concrete.
-. Vuz = 97.43 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1675.70 kN.
-. phiVcz = phi * Vcz = 1508.13 kN.

-. Vuy = 48.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1644.55 kN.
-. phiVcy = phi * Vcy = 1480.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2308.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5472.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2308.37 kN.
-. phiVsz = phi*Vsz = 2077.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2297.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5503.94 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2297.84 kN.
-. phiVsy = phi*Vsy = 2068.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 108.616 kN.
-. Vr = 3548.152 kN.
-. Ratio = Vu / Vr = 0.031 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 120.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 120.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112233,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2757.18       -35.82       -15.62       -27.93       -13.23
           ------------------------------------------------------------------------------
            DL+LL+Others     2757.18       -35.82       -15.62       -27.93       -13.23
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       15.62 kN-m.
           -. End Moments (My2) =       35.82 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -15.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -15.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       13.23 kN-m.
          -. End Moments (Mz2) =       27.93 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -13.23 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -13.23 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       138.341 kN-m.
          -. Mrz        =       117.066 kN-m.
          -. Mr         =       181.225 kN-m.
          -. Pu/Pr      =   0.113  --->  O.K !
          -. Muy/Mry    =   0.113  --->  O.K !
          -. Muz/Mrz    =   0.113  --->  O.K !
          -. Mu/Mr      =   0.113  --->  O.K !
          -. Ratio      =   0.113  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2506.07 kN.
          -. Vuz    =         60.70 kN.
          -. Muy    =        -23.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.76

          -. Vuy    =         32.31 kN.
          -. Muz    =        -15.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.40 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.69
```

( ). Compute shear strength of concrete.
-. Vuz = 60.70 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1698.97 kN.
-. phiVcz = phi * Vcz = 1529.07 kN.

-. Vuy = 32.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1668.85 kN.
-. phiVcy = phi * Vcy = 1501.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2316.03 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5449.52 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2316.03 kN.
-. phiVsz = phi*Vsz = 2084.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2306.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5479.63 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2306.08 kN.
-. phiVsy = phi*Vsy = 2075.48 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 68.763 kN.
-. Vr = 3577.443 kN.
-. Ratio = Vu / Vr = 0.019 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 76.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 76.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112234,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2773.85       -15.62        -4.79       -13.23        -4.72
           ------------------------------------------------------------------------------
            DL+LL+Others     2773.85       -15.62        -4.79       -13.23        -4.72
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.79 kN-m.
           -. End Moments (My2) =       15.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.72 kN-m.
          -. End Moments (Mz2) =       13.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.72 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        42.143 kN-m.
          -. Mrz        =        41.548 kN-m.
          -. Mr         =        59.180 kN-m.
          -. Pu/Pr      =   0.114  --->  O.K !
          -. Muy/Mry    =   0.114  --->  O.K !
          -. Muz/Mrz    =   0.114  --->  O.K !
          -. Mu/Mr      =   0.114  --->  O.K !
          -. Ratio      =   0.114  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2522.73 kN.
          -. Vuz    =         32.41 kN.
          -. Muy    =         -7.01 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.79

          -. Vuy    =         19.43 kN.
          -. Muz    =         -5.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.73
```

( ). Compute shear strength of concrete.
-. Vuz = 32.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1713.27 kN.
-. phiVcz = phi * Vcz = 1541.94 kN.

-. Vuy = 19.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1683.81 kN.
-. phiVcy = phi * Vcy = 1515.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2320.65 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5435.22 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2320.65 kN.
-. phiVsz = phi*Vsz = 2088.59 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2311.06 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5464.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2311.06 kN.
-. phiVsy = phi*Vsy = 2079.95 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 37.793 kN.
-. Vr = 3595.385 kN.
-. Ratio = Vu / Vr = 0.011 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 41.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 41.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112235,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2790.51        -4.79        -0.52        -4.72        -0.84
           ------------------------------------------------------------------------------
            DL+LL+Others     2790.51        -4.79        -0.52        -4.72        -0.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.52 kN-m.
           -. End Moments (My2) =        4.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -0.52 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -0.52 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.84 kN-m.
          -. End Moments (Mz2) =        4.72 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.84 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         4.592 kN-m.
          -. Mrz        =         7.369 kN-m.
          -. Mr         =         8.682 kN-m.
          -. Pu/Pr      =   0.114  --->  O.K !
          -. Muy/Mry    =   0.114  --->  O.K !
          -. Muz/Mrz    =   0.114  --->  O.K !
          -. Mu/Mr      =   0.114  --->  O.K !
          -. Ratio      =   0.114  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2539.39 kN.
          -. Vuz    =         12.64 kN.
          -. Muy    =         -0.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.81

          -. Vuy    =          9.42 kN.
          -. Muz    =         -1.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.75
```

( ). Compute shear strength of concrete.
-. Vuz = 12.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1722.94 kN.
-. phiVcz = phi * Vcz = 1550.65 kN.

-. Vuy = 9.42 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1693.93 kN.
-. phiVcy = phi * Vcy = 1524.54 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2323.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5425.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2323.74 kN.
-. phiVsz = phi*Vsz = 2091.37 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2314.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5454.56 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2314.39 kN.
-. phiVsy = phi*Vsy = 2082.95 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.762 kN.
-. Vr = 3607.486 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 17.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 17.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =112236,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2807.17        -0.52         0.00        -0.84         0.00
           ---------------------------------------------------------------------------
            DL+LL+Others     2807.17        -0.52         0.00        -0.84         0.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        0.52 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.115  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.115  --->  O.K !
          -. Ratio      =   0.115  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2556.04 kN.
          -. Vuz    =          1.39 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.29 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.76

          -. Vuy    =          2.24 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.29 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.76
```

( ). Compute shear strength of concrete.
-. Vuz = 1.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1699.05 kN.
-. phiVcz = phi * Vcz = 1529.15 kN.

-. Vuy = 2.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1699.05 kN.
-. phiVcy = phi * Vcy = 1529.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2316.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5449.43 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2316.06 kN.
-. phiVsz = phi*Vsz = 2084.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2316.06 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5449.43 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2316.06 kN.
-. phiVsy = phi*Vsy = 2084.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 2.638 kN.
-. Vr = 3613.598 kN.
-. Ratio = Vu / Vr =7.301e-004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 2.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 2.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113102,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2597.46      -229.36      -213.05      -333.72      -477.65
           ------------------------------------------------------------------------------
            DL+LL+Others     2597.46      -229.36      -213.05      -333.72      -477.65
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      213.05 kN-m.
           -. End Moments (My2) =      229.36 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -213.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -213.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      333.72 kN-m.
          -. End Moments (Mz2) =      477.65 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -477.65 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -477.65 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     18464.174 kN.
          -. Mry        =      1515.395 kN-m.
          -. Mrz        =      3402.370 kN-m.
          -. Mr         =      3724.586 kN-m.
          -. Pu/Pr      =   0.141  --->  O.K !
          -. Muy/Mry    =   0.141  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.141  --->  O.K !
          -. Ratio      =   0.141  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2336.48 kN.
          -. Vuz    =        985.79 kN.
          -. Muy    =       -265.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        539.75 kN.
          -. Muz    =       -418.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.77
```

( ). Compute shear strength of concrete.
-. Vuz = 985.79 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1291.58 kN.
-. phiVcz = phi * Vcz = 1162.42 kN.

-. Vuy = 539.75 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1249.47 kN.
-. phiVcy = phi * Vcy = 1124.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2150.86 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5856.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2150.86 kN.
-. phiVsz = phi*Vsz = 1935.78 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2129.03 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5899.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2129.03 kN.
-. phiVsy = phi*Vsy = 1916.13 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1123.883 kN.
-. Vr = 3040.652 kN.
-. Ratio = Vu / Vr = 0.370 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1248.76 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1248.76 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113103,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2614.18      -213.05      -451.29      -477.65      -695.68
           ------------------------------------------------------------------------------
            DL+LL+Others     2614.18      -213.05      -451.29      -477.65      -695.68
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      213.05 kN-m.
           -. End Moments (My2) =      451.29 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -451.29 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -451.29 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      477.65 kN-m.
          -. End Moments (Mz2) =      695.68 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -695.68 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -695.68 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     13921.514 kN.
          -. Mry        =      2409.406 kN-m.
          -. Mrz        =      3712.533 kN-m.
          -. Mr         =      4425.849 kN-m.
          -. Pu/Pr      =   0.188  --->  O.K !
          -. Muy/Mry    =   0.187  --->  O.K !
          -. Muz/Mrz    =   0.187  --->  O.K !
          -. Mu/Mr      =   0.188  --->  O.K !
          -. Ratio      =   0.188  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2353.18 kN.
          -. Vuz    =        870.72 kN.
          -. Muy    =       -676.83 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        479.77 kN.
          -. Muz    =       -494.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.85
```

( ). Compute shear strength of concrete.
-. Vuz = 870.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1331.16 kN.
-. phiVcz = phi * Vcz = 1198.04 kN.

-. Vuy = 479.77 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1289.65 kN.
-. phiVcy = phi * Vcy = 1160.69 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2170.39 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5817.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2170.39 kN.
-. phiVsz = phi*Vsz = 1953.35 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2149.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5858.83 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2149.89 kN.
-. phiVsy = phi*Vsy = 1934.90 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 994.148 kN.
-. Vr = 3095.589 kN.
-. Ratio = Vu / Vr = 0.321 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1104.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1104.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113104,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2369.89      -676.83     -1040.41      -494.43      -612.14
           ------------------------------------------------------------------------------
            DL+LL+Others     2369.89      -676.83     -1040.41      -494.43      -612.14
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      676.83 kN-m.
           -. End Moments (My2) =     1040.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1040.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1040.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      494.43 kN-m.
          -. End Moments (Mz2) =      612.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -612.14 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -612.14 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9503.459 kN.
          -. Mry        =      4200.602 kN-m.
          -. Mrz        =      2475.295 kN-m.
          -. Mr         =      4875.668 kN-m.
          -. Pu/Pr      =   0.249  --->  O.K !
          -. Muy/Mry    =   0.248  --->  O.K !
          -. Muz/Mrz    =   0.247  --->  O.K !
          -. Mu/Mr      =   0.249  --->  O.K !
          -. Ratio      =   0.249  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2369.89 kN.
          -. Vuz    =        755.51 kN.
          -. Muy    =      -1040.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.20 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.85

          -. Vuy    =        419.59 kN.
          -. Muz    =       -612.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 755.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1286.97 kN.
-. phiVcz = phi * Vcz = 1158.27 kN.

-. Vuy = 419.59 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1244.80 kN.
-. phiVcy = phi * Vcy = 1120.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2148.53 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5861.52 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2148.53 kN.
-. phiVsz = phi*Vsz = 1933.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2126.53 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5903.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2126.53 kN.
-. phiVsy = phi*Vsy = 1913.88 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 864.207 kN.
-. Vr = 3034.196 kN.
-. Ratio = Vu / Vr = 0.285 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 960.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 960.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113105,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            280.18      1074.17      1378.45       560.48       699.43
           ------------------------------------------------------------------------------
            DL+LL+Others      280.18      1074.17      1378.45       560.48       699.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1074.17 kN-m.
           -. End Moments (My2) =     1378.45 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1378.45 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1378.45 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      560.48 kN-m.
          -. End Moments (Mz2) =      699.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      699.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      699.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       912.770 kN.
          -. Mry        =      4506.904 kN-m.
          -. Mrz        =      2283.300 kN-m.
          -. Mr         =      5052.291 kN-m.
          -. Pu/Pr      =   0.307  --->  O.K !
          -. Muy/Mry    =   0.306  --->  O.K !
          -. Muz/Mrz    =   0.306  --->  O.K !
          -. Mu/Mr      =   0.307  --->  O.K !
          -. Ratio      =   0.307  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2386.59 kN.
          -. Vuz    =        641.21 kN.
          -. Muy    =      -1349.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.76

          -. Vuy    =        359.79 kN.
          -. Muz    =       -730.89 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67
```

( ). Compute shear strength of concrete.
-. Vuz = 641.21 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1248.87 kN.
-. phiVcz = phi * Vcz = 1123.98 kN.

-. Vuy = 359.79 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1206.24 kN.
-. phiVcy = phi * Vcy = 1085.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2128.71 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5899.62 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2128.71 kN.
-. phiVsz = phi*Vsz = 1915.84 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2105.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5942.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2105.39 kN.
-. phiVsy = phi*Vsy = 1894.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 735.259 kN.
-. Vr = 2980.460 kN.
-. Ratio = Vu / Vr = 0.247 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 816.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 816.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0025 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113106,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            292.13      1378.45      1628.87       699.43       820.56
           ------------------------------------------------------------------------------
            DL+LL+Others      292.13      1378.45      1628.87       699.43       820.56
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1378.45 kN-m.
           -. End Moments (My2) =     1628.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1628.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1628.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      699.43 kN-m.
          -. End Moments (Mz2) =      820.56 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      820.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      820.56 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       814.485 kN.
          -. Mry        =      4505.198 kN-m.
          -. Mrz        =      2268.486 kN-m.
          -. Mr         =      5044.089 kN-m.
          -. Pu/Pr      =   0.359  --->  O.K !
          -. Muy/Mry    =   0.362  --->  O.K !
          -. Muz/Mrz    =   0.362  --->  O.K !
          -. Mu/Mr      =   0.362  --->  O.K !
          -. Ratio      =   0.362  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2403.29 kN.
          -. Vuz    =        528.99 kN.
          -. Muy    =      -1604.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =        301.01 kN.
          -. Muz    =       -833.94 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61
```

( ). Compute shear strength of concrete.
-. Vuz = 528.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1221.13 kN.
-. phiVcz = phi * Vcz = 1099.02 kN.

-. Vuy = 301.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1178.24 kN.
-. phiVcy = phi * Vcy = 1060.41 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2113.68 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5927.35 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2113.68 kN.
-. phiVsz = phi*Vsz = 1902.31 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2089.36 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5970.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2089.36 kN.
-. phiVsy = phi*Vsy = 1880.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 608.635 kN.
-. Vr = 2940.838 kN.
-. Ratio = Vu / Vr = 0.207 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 676.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 676.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113107,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            304.08      1628.87      1827.36       820.56       920.33
           ---------------------------------------------------------------------------
            DL+LL+Others      304.08      1628.87      1827.36       820.56       920.33
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1628.87 kN-m.
           -. End Moments (My2) =     1827.36 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1827.36 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1827.36 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      820.56 kN-m.
          -. End Moments (Mz2) =      920.33 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      920.33 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      920.33 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       749.417 kN.
          -. Mry        =      4499.849 kN-m.
          -. Mrz        =      2267.028 kN-m.
          -. Mr         =      5038.656 kN-m.
          -. Pu/Pr      =   0.406  --->  O.K !
          -. Muy/Mry    =   0.406  --->  O.K !
          -. Muz/Mrz    =   0.406  --->  O.K !
          -. Mu/Mr      =   0.406  --->  O.K !
          -. Ratio      =   0.406  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2419.98 kN.
          -. Vuz    =        419.92 kN.
          -. Muy    =      -1807.46 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.75 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.66

          -. Vuy    =        243.90 kN.
          -. Muz    =       -917.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.57
```

( ). Compute shear strength of concrete.
-. Vuz = 419.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1202.49 kN.
-. phiVcz = phi * Vcz = 1082.24 kN.

-. Vuy = 243.90 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1159.45 kN.
-. phiVcy = phi * Vcy = 1043.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2103.27 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5946.00 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2103.27 kN.
-. phiVsz = phi*Vsz = 1892.95 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2078.28 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5989.04 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2078.28 kN.
-. phiVsy = phi*Vsy = 1870.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 485.613 kN.
-. Vr = 2913.952 kN.
-. Ratio = Vu / Vr = 0.167 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 539.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 539.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113108,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            316.03      1827.36      1980.91       920.33       999.99
           ------------------------------------------------------------------------------
            DL+LL+Others      316.03      1827.36      1980.91       920.33       999.99
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1827.36 kN-m.
           -. End Moments (My2) =     1980.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1980.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1980.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      920.33 kN-m.
          -. End Moments (Mz2) =      999.99 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      999.99 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      999.99 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       719.431 kN.
          -. Mry        =      4495.128 kN-m.
          -. Mrz        =      2270.854 kN-m.
          -. Mr         =      5036.165 kN-m.
          -. Pu/Pr      =   0.439  --->  O.K !
          -. Muy/Mry    =   0.441  --->  O.K !
          -. Muz/Mrz    =   0.440  --->  O.K !
          -. Mu/Mr      =   0.441  --->  O.K !
          -. Ratio      =   0.441  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2436.68 kN.
          -. Vuz    =        315.14 kN.
          -. Muy    =      -1965.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.64

          -. Vuy    =        189.16 kN.
          -. Muz    =       -983.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 315.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1191.00 kN.
-. phiVcz = phi * Vcz = 1071.90 kN.

-. Vuy = 189.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1147.88 kN.
-. phiVcy = phi * Vcy = 1033.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2096.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5957.48 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2096.74 kN.
-. phiVsz = phi*Vsz = 1887.07 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2071.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6000.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2071.32 kN.
-. phiVsy = phi*Vsy = 1864.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 367.554 kN.
-. Vr = 2897.280 kN.
-. Ratio = Vu / Vr = 0.127 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 408.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 408.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113109,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            327.99      1980.91      2087.70       999.99      1056.47
           ------------------------------------------------------------------------------
            DL+LL+Others      327.99      1980.91      2087.70       999.99      1056.47
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1980.91 kN-m.
           -. End Moments (My2) =     2087.70 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2087.70 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2087.70 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      999.99 kN-m.
          -. End Moments (Mz2) =     1056.47 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1056.47 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1056.47 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       704.078 kN.
          -. Mry        =      4491.548 kN-m.
          -. Mrz        =      2275.128 kN-m.
          -. Mr         =      5034.899 kN-m.
          -. Pu/Pr      =   0.466  --->  O.K !
          -. Muy/Mry    =   0.465  --->  O.K !
          -. Muz/Mrz    =   0.464  --->  O.K !
          -. Mu/Mr      =   0.466  --->  O.K !
          -. Ratio      =   0.466  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2453.37 kN.
          -. Vuz    =        215.73 kN.
          -. Muy    =      -2075.57 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =        137.67 kN.
          -. Muz    =      -1028.60 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53
```

( ). Compute shear strength of concrete.
-. Vuz = 215.73 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1186.55 kN.
-. phiVcz = phi * Vcz = 1067.90 kN.

-. Vuy = 137.67 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1143.40 kN.
-. phiVcy = phi * Vcy = 1029.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2094.18 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5961.93 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2094.18 kN.
-. phiVsz = phi*Vsz = 1884.76 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2068.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6005.08 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2068.59 kN.
-. phiVsy = phi*Vsy = 1861.74 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 255.918 kN.
-. Vr = 2890.799 kN.
-. Ratio = Vu / Vr = 0.089 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 284.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 284.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113110,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            339.94      2087.70      2147.99      1056.47      1093.61
           ---------------------------------------------------------------------------
            DL+LL+Others      339.94      2087.70      2147.99      1056.47      1093.61
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2087.70 kN-m.
           -. End Moments (My2) =     2147.99 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2147.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2147.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1056.47 kN-m.
          -. End Moments (Mz2) =     1093.61 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1093.61 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1093.61 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       717.257 kN.
          -. Mry        =      4487.003 kN-m.
          -. Mrz        =      2286.622 kN-m.
          -. Mr         =      5036.053 kN-m.
          -. Pu/Pr      =   0.474  --->  O.K !
          -. Muy/Mry    =   0.479  --->  O.K !
          -. Muz/Mrz    =   0.478  --->  O.K !
          -. Mu/Mr      =   0.479  --->  O.K !
          -. Ratio      =   0.479  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2470.07 kN.
          -. Vuz    =        122.82 kN.
          -. Muy    =      -2139.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =         91.03 kN.
          -. Muz    =      -1056.20 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 122.82 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1188.42 kN.
-. phiVcz = phi * Vcz = 1069.58 kN.

-. Vuy = 91.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1145.29 kN.
-. phiVcy = phi * Vcy = 1030.76 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2095.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5960.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2095.26 kN.
-. phiVsz = phi*Vsz = 1885.73 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2069.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6003.20 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2069.74 kN.
-. phiVsy = phi*Vsy = 1862.77 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 152.881 kN.
-. Vr = 2893.526 kN.
-. Ratio = Vu / Vr = 0.053 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 169.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 169.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113111,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            351.90      2147.99      2158.41      1093.61      1104.94
           ---------------------------------------------------------------------------
            DL+LL+Others      351.90      2147.99      2158.41      1093.61      1104.94
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2147.99 kN-m.
           -. End Moments (My2) =     2158.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2158.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2158.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1093.61 kN-m.
          -. End Moments (Mz2) =     1104.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1104.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1104.94 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       730.533 kN.
          -. Mry        =      4483.013 kN-m.
          -. Mrz        =      2296.969 kN-m.
          -. Mr         =      5037.209 kN-m.
          -. Pu/Pr      =   0.482  --->  O.K !
          -. Muy/Mry    =   0.481  --->  O.K !
          -. Muz/Mrz    =   0.481  --->  O.K !
          -. Mu/Mr      =   0.482  --->  O.K !
          -. Ratio      =   0.482  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2486.76 kN.
          -. Vuz    =         25.50 kN.
          -. Muy    =      -2152.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.65

          -. Vuy    =         52.80 kN.
          -. Muz    =      -1060.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56
```

```
     ( ). Compute shear strength of concrete.
          -. Vuz       =       25.50 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1197.54 kN.
          -. phiVcz    = phi * Vcz =     1077.79 kN.

          -. Vuy       =       52.80 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1154.46 kN.
          -. phiVcy    = phi * Vcy =     1039.02 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2100.47 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5950.94 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2100.47 kN.
          -. phiVsz   = phi*Vsz =     1890.43 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2075.29 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5994.02 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2075.29 kN.
          -. phiVsy   = phi*Vsy =     1867.76 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =      58.633 kN.
          -. Vr       =    2906.783 kN.
          -. Ratio    = Vu / Vr = 0.020  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.75
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =       65.15 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =       65.15 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy =
0.0036 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy =
0.0036 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =   0.0036 m^2.
          -. As      =   0.0363 m^2.
          -. As_req < As  --->  O.K !
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113112,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            351.86      2158.41      2110.62      1104.94      1085.28
           ------------------------------------------------------------------------------
            DL+LL+Others      351.86      2158.41      2110.62      1104.94      1085.28
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2110.62 kN-m.
           -. End Moments (My2) =     2158.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2158.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2158.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1085.28 kN-m.
          -. End Moments (Mz2) =     1104.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1104.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1104.94 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       730.533 kN.
          -. Mry        =      4483.013 kN-m.
          -. Mrz        =      2296.969 kN-m.
          -. Mr         =      5037.209 kN-m.
          -. Pu/Pr      =   0.482  --->  O.K !
          -. Muy/Mry    =   0.481  --->  O.K !
          -. Muz/Mrz    =   0.481  --->  O.K !
          -. Mu/Mr      =   0.482  --->  O.K !
          -. Ratio      =   0.482  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2486.79 kN.
          -. Vuz    =         98.11 kN.
          -. Muy    =      -2152.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =         66.89 kN.
          -. Muz    =      -1060.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 98.11 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1189.69 kN.
-. phiVcz = phi * Vcz = 1070.72 kN.

-. Vuy = 66.89 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1146.56 kN.
-. phiVcy = phi * Vcy = 1031.91 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2095.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5958.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2095.99 kN.
-. phiVsz = phi*Vsz = 1886.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2070.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6001.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2070.52 kN.
-. phiVsy = phi*Vsy = 1863.47 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 118.742 kN.
-. Vr = 2895.372 kN.
-. Ratio = Vu / Vr = 0.041 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 131.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 131.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113113,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            363.82      2110.62      2063.51      1085.28      1066.17
           ---------------------------------------------------------------------------
            DL+LL+Others      363.82      2110.62      2063.51      1085.28      1066.17
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2063.51 kN-m.
           -. End Moments (My2) =     2110.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2110.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2110.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1066.17 kN-m.
          -. End Moments (Mz2) =     1085.28 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1085.28 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1085.28 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       771.344 kN.
          -. Mry        =      4482.335 kN-m.
          -. Mrz        =      2305.819 kN-m.
          -. Mr         =      5040.647 kN-m.
          -. Pu/Pr      =   0.472  --->  O.K !
          -. Muy/Mry    =   0.471  --->  O.K !
          -. Muz/Mrz    =   0.471  --->  O.K !
          -. Mu/Mr      =   0.472  --->  O.K !
          -. Ratio      =   0.472  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2503.48 kN.
          -. Vuz    =         96.93 kN.
          -. Muy    =      -2107.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.65

          -. Vuy    =         66.49 kN.
          -. Muz    =      -1036.26 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.11 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.55
```

( ). Compute shear strength of concrete.
-. Vuz = 96.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1196.51 kN.
-. phiVcz = phi * Vcz = 1076.86 kN.

-. Vuy = 66.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1153.42 kN.
-. phiVcy = phi * Vcy = 1038.08 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2099.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5951.98 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2099.88 kN.
-. phiVsz = phi*Vsz = 1889.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2074.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5995.06 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2074.67 kN.
-. phiVsy = phi*Vsy = 1867.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 117.544 kN.
-. Vr = 2905.280 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 130.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 130.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113114,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            375.79      2063.51      2016.87      1066.17      1047.54
           ------------------------------------------------------------------------------
            DL+LL+Others      375.79      2063.51      2016.87      1066.17      1047.54
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2016.87 kN-m.
           -. End Moments (My2) =     2063.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2063.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2063.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1047.54 kN-m.
          -. End Moments (Mz2) =     1066.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1066.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1066.17 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =       820.421 kN.
           -. Mry        =      4482.000 kN-m.
           -. Mrz        =      2315.446 kN-m.
           -. Mr         =      5044.761 kN-m.
           -. Pu/Pr      =   0.458  --->  O.K !
           -. Muy/Mry    =   0.460  --->  O.K !
           -. Muz/Mrz    =   0.460  --->  O.K !
           -. Mu/Mr      =   0.460  --->  O.K !
           -. Ratio      =   0.460  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2520.16 kN.
           -. Vuz    =         96.01 kN.
           -. Muy    =      -2062.58 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  32.74 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.66

           -. Vuy    =         66.19 kN.
           -. Muz    =      -1012.76 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  33.06 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.57
```

( ). Compute shear strength of concrete.
-. Vuz = 96.01 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1203.24 kN.
-. phiVcz = phi * Vcz = 1082.91 kN.

-. Vuy = 66.19 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1160.20 kN.
-. phiVcy = phi * Vcy = 1044.18 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2103.70 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5945.25 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2103.70 kN.
-. phiVsz = phi*Vsz = 1893.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2078.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5988.29 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2078.73 kN.
-. phiVsy = phi*Vsy = 1870.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 116.613 kN.
-. Vr = 2915.036 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 129.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 129.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113115,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            387.75      2016.87      1924.28      1047.54      1003.85
           ------------------------------------------------------------------------------
            DL+LL+Others      387.75      2016.87      1924.28      1047.54      1003.85
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1924.28 kN-m.
           -. End Moments (My2) =     2016.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2016.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2016.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1003.85 kN-m.
          -. End Moments (Mz2) =     1047.54 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1047.54 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1047.54 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

( ). Check tensile reinforcement.
-. Rho = 0.0321
-. Rho > Rho_max ---> Not Acceptable !!!

( ). Check moment capacity.
-. Pr_max = 24404.708 kN.
-. Pr = 856.571 kN.
-. Mry = 4480.117 kN-m.
-. Mrz = 2325.671 kN-m.
-. Mr = 5047.791 kN-m.
-. Pu/Pr = 0.453 ---> O.K !
-. Muy/Mry = 0.450 ---> O.K !
-. Muz/Mrz = 0.450 ---> O.K !
-. Mu/Mr = 0.453 ---> O.K !
-. Ratio = 0.453 ---> O.K !

[[[*]]] ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.

( ). Compute shear parameter. (LCB = 151, POS = I)
-. phi = 0.90
-. Av = 0.0006 m^2.
-. Pu = 2536.85 kN.
-. Vuz = 184.82 kN.
-. Muy = -2018.37 kN-m.
-. bvz = 1.20 m.
-. dvz = MAX[dvz_calc, 0.9*dz, 0.72*Hc] = 0.86 m.
-. thetaz = 32.78 Deg. [Clause 5.8.3.4.2]
-. betaz = 2.65

-. Vuy = 98.75 kN.
-. Muz = -989.74 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.10 Deg. [Clause 5.8.3.4.2]
-. betay = 2.56

( ). Compute shear strength of concrete.
-. Vuz = 184.82 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1197.48 kN.
-. phiVcz = phi * Vcz = 1077.73 kN.

-. Vuy = 98.75 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1154.40 kN.
-. phiVcy = phi * Vcy = 1038.96 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2100.44 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5951.01 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2100.44 kN.
-. phiVsz = phi*Vsz = 1890.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2075.25 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5994.09 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2075.25 kN.
-. phiVsy = phi*Vsy = 1867.73 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 209.549 kN.
-. Vr = 2906.689 kN.
-. Ratio = Vu / Vr = 0.072 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 232.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 232.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113116,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            399.71      1924.28      1795.75      1003.85       940.23
           ------------------------------------------------------------------------------
            DL+LL+Others      399.71      1924.28      1795.75      1003.85       940.23
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1795.75 kN-m.
           -. End Moments (My2) =     1924.28 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1924.28 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1924.28 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      940.23 kN-m.
          -. End Moments (Mz2) =     1003.85 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1003.85 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1003.85 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       930.101 kN.
          -. Mry        =      4482.229 kN-m.
          -. Mrz        =      2334.810 kN-m.
          -. Mr         =      5053.881 kN-m.
          -. Pu/Pr      =   0.430  --->  O.K !
          -. Muy/Mry    =   0.429  --->  O.K !
          -. Muz/Mrz    =   0.430  --->  O.K !
          -. Mu/Mr      =   0.430  --->  O.K !
          -. Ratio      =   0.430  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2553.53 kN.
          -. Vuz    =        254.96 kN.
          -. Muy    =      -1927.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.75 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.66

          -. Vuy    =        128.46 kN.
          -. Muz    =       -944.39 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.07 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56
```

( ). Compute shear strength of concrete.
-. Vuz = 254.96 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1201.85 kN.
-. phiVcz = phi * Vcz = 1081.67 kN.

-. Vuy = 128.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1158.81 kN.
-. phiVcy = phi * Vcy = 1042.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2102.92 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5946.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2102.92 kN.
-. phiVsz = phi*Vsz = 1892.62 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2077.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5989.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2077.90 kN.
-. phiVsy = phi*Vsy = 1870.11 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 285.497 kN.
-. Vr = 2913.033 kN.
-. Ratio = Vu / Vr = 0.098 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 317.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 317.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113117,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            411.68      1795.75      1641.06       940.23       861.74
           ------------------------------------------------------------------------------
            DL+LL+Others      411.68      1795.75      1641.06       940.23       861.74
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1641.06 kN-m.
           -. End Moments (My2) =     1795.75 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1795.75 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1795.75 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      861.74 kN-m.
          -. End Moments (Mz2) =      940.23 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      940.23 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      940.23 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1027.824 kN.
          -. Mry        =      4487.078 kN-m.
          -. Mrz        =      2342.866 kN-m.
          -. Mr         =      5061.906 kN-m.
          -. Pu/Pr      =   0.401  --->  O.K !
          -. Muy/Mry    =   0.400  --->  O.K !
          -. Muz/Mrz    =   0.401  --->  O.K !
          -. Mu/Mr      =   0.401  --->  O.K !
          -. Ratio      =   0.401  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2570.21 kN.
          -. Vuz    =        308.38 kN.
          -. Muy    =      -1800.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.66 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.69

          -. Vuy    =        152.26 kN.
          -. Muz    =       -881.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.97 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.59
```

( ). Compute shear strength of concrete.
-. Vuz = 308.38 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1214.92 kN.
-. phiVcz = phi * Vcz = 1093.43 kN.

-. Vuy = 152.26 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1171.97 kN.
-. phiVcy = phi * Vcy = 1054.78 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2110.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5933.57 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2110.24 kN.
-. phiVsz = phi*Vsz = 1899.21 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2085.70 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5976.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2085.70 kN.
-. phiVsy = phi*Vsy = 1877.13 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 343.922 kN.
-. Vr = 2931.903 kN.
-. Ratio = Vu / Vr = 0.117 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 382.14 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 382.14 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113118,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            423.65      1641.06      1479.72       861.74       779.37
           ------------------------------------------------------------------------------
            DL+LL+Others      423.65      1641.06      1479.72       861.74       779.37
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1479.72 kN-m.
           -. End Moments (My2) =     1641.06 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1641.06 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1641.06 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      779.37 kN-m.
          -. End Moments (Mz2) =      861.74 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      861.74 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      861.74 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1154.316 kN.
          -. Mry        =      4493.079 kN-m.
          -. Mrz        =      2351.604 kN-m.
          -. Mr         =      5071.273 kN-m.
          -. Pu/Pr      =   0.367  --->  O.K !
          -. Muy/Mry    =   0.365  --->  O.K !
          -. Muz/Mrz    =   0.366  --->  O.K !
          -. Mu/Mr      =   0.367  --->  O.K !
          -. Ratio      =   0.367  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2586.89 kN.
          -. Vuz    =        322.00 kN.
          -. Muy    =      -1646.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74

          -. Vuy    =        158.60 kN.
          -. Muz    =       -805.68 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 322.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1239.12 kN.
-. phiVcz = phi * Vcz = 1115.21 kN.

-. Vuy = 158.60 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1196.39 kN.
-. phiVcy = phi * Vcy = 1076.75 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2123.48 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5909.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2123.48 kN.
-. phiVsz = phi*Vsz = 1911.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2099.82 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5952.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2099.82 kN.
-. phiVsy = phi*Vsy = 1889.83 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 358.941 kN.
-. Vr = 2966.583 kN.
-. Ratio = Vu / Vr = 0.121 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 398.82 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 398.82 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113119,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            435.62      1479.72      1316.14       779.37       695.60
           ------------------------------------------------------------------------------
            DL+LL+Others      435.62      1479.72      1316.14       779.37       695.60
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1316.14 kN-m.
           -. End Moments (My2) =     1479.72 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1479.72 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1479.72 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      695.60 kN-m.
          -. End Moments (Mz2) =      779.37 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      779.37 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      779.37 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =      1335.586 kN.
           -. Mry        =      4500.308 kN-m.
           -. Mrz        =      2364.036 kN-m.
           -. Mr         =      5083.447 kN-m.
           -. Pu/Pr      =   0.326  --->  O.K !
           -. Muy/Mry    =   0.329  --->  O.K !
           -. Muz/Mrz    =   0.330  --->  O.K !
           -. Mu/Mr      =   0.330  --->  O.K !
           -. Ratio      =   0.330  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2603.57 kN.
           -. Vuz    =        326.67 kN.
           -. Muy    =      -1485.28 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  32.32 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.80

           -. Vuy    =        160.72 kN.
           -. Muz    =       -726.65 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.60 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 326.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1267.04 kN.
-. phiVcz = phi * Vcz = 1140.33 kN.

-. Vuy = 160.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1224.61 kN.
-. phiVcy = phi * Vcy = 1102.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2138.28 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5881.45 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2138.28 kN.
-. phiVsz = phi*Vsz = 1924.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2115.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5923.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2115.59 kN.
-. phiVsy = phi*Vsy = 1904.03 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 364.067 kN.
-. Vr = 3006.186 kN.
-. Ratio = Vu / Vr = 0.121 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 404.52 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 404.52 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113120,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2620.25     -1322.02     -1157.58      -646.56      -566.00
           ------------------------------------------------------------------------------
            DL+LL+Others     2620.25     -1322.02     -1157.58      -646.56      -566.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1157.58 kN-m.
           -. End Moments (My2) =     1322.02 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1322.02 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1322.02 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      566.00 kN-m.
          -. End Moments (Mz2) =      646.56 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -646.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -646.56 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8730.892 kN.
          -. Mry        =      4437.559 kN-m.
          -. Mrz        =      2164.756 kN-m.
          -. Mr         =      4937.418 kN-m.
          -. Pu/Pr      =   0.300  --->  O.K !
          -. Muy/Mry    =   0.298  --->  O.K !
          -. Muz/Mrz    =   0.299  --->  O.K !
          -. Mu/Mr      =   0.300  --->  O.K !
          -. Ratio      =   0.300  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2620.25 kN.
          -. Vuz    =        328.99 kN.
          -. Muy    =      -1322.02 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.14 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.87

          -. Vuy    =        161.48 kN.
          -. Muz    =       -646.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.78
```

( ). Compute shear strength of concrete.
-. Vuz = 328.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1297.12 kN.
-. phiVcz = phi * Vcz = 1167.41 kN.

-. Vuy = 161.48 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1255.09 kN.
-. phiVcy = phi * Vcy = 1129.58 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2153.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5851.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2153.66 kN.
-. phiVsz = phi*Vsz = 1938.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2132.01 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5893.39 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2132.01 kN.
-. phiVsy = phi*Vsy = 1918.81 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 366.483 kN.
-. Vr = 3048.393 kN.
-. Ratio = Vu / Vr = 0.120 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 407.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 407.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113121,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2636.92     -1157.58      -996.67      -566.00      -487.25
           ------------------------------------------------------------------------------
            DL+LL+Others     2636.92     -1157.58      -996.67      -566.00      -487.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      996.67 kN-m.
           -. End Moments (My2) =     1157.58 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1157.58 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1157.58 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      487.25 kN-m.
          -. End Moments (Mz2) =      566.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -566.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -566.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9832.898 kN.
          -. Mry        =      4357.903 kN-m.
          -. Mrz        =      2125.183 kN-m.
          -. Mr         =      4848.476 kN-m.
          -. Pu/Pr      =   0.268  --->  O.K !
          -. Muy/Mry    =   0.266  --->  O.K !
          -. Muz/Mrz    =   0.266  --->  O.K !
          -. Mu/Mr      =   0.268  --->  O.K !
          -. Ratio      =   0.268  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2636.92 kN.
          -. Vuz    =        321.85 kN.
          -. Muy    =      -1157.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.95

          -. Vuy    =        157.73 kN.
          -. Muz    =       -566.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.85
```

( ). Compute shear strength of concrete.
-. Vuz = 321.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1330.61 kN.
-. phiVcz = phi * Vcz = 1197.55 kN.

-. Vuy = 157.73 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1289.10 kN.
-. phiVcy = phi * Vcy = 1160.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2170.13 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5817.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2170.13 kN.
-. phiVsz = phi*Vsz = 1953.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2149.61 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5859.39 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2149.61 kN.
-. phiVsy = phi*Vsy = 1934.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 358.426 kN.
-. Vr = 3094.836 kN.
-. Ratio = Vu / Vr = 0.116 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 398.25 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 398.25 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113122,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2653.60      -996.67      -842.96      -487.25      -412.07
           ------------------------------------------------------------------------------
            DL+LL+Others     2653.60      -996.67      -842.96      -487.25      -412.07
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      842.96 kN-m.
           -. End Moments (My2) =      996.67 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -996.67 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -996.67 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      412.07 kN-m.
          -. End Moments (Mz2) =      487.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -487.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -487.25 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11317.390 kN.
          -. Mry        =      4228.918 kN-m.
          -. Mrz        =      2076.060 kN-m.
          -. Mr         =      4711.026 kN-m.
          -. Pu/Pr      =   0.234  --->  O.K !
          -. Muy/Mry    =   0.236  --->  O.K !
          -. Muz/Mrz    =   0.235  --->  O.K !
          -. Mu/Mr      =   0.236  --->  O.K !
          -. Ratio      =   0.236  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2653.60 kN.
          -. Vuz    =        307.43 kN.
          -. Muy    =       -996.67 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.74 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.02

          -. Vuy    =        150.51 kN.
          -. Muz    =       -487.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.97 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.93
```

( ). Compute shear strength of concrete.
-. Vuz = 307.43 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1366.46 kN.
-. phiVcz = phi * Vcz = 1229.82 kN.

-. Vuy = 150.51 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1325.60 kN.
-. phiVcy = phi * Vcy = 1193.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2187.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5782.02 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2187.06 kN.
-. phiVsz = phi*Vsz = 1968.35 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2167.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5822.88 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2167.71 kN.
-. phiVsy = phi*Vsy = 1950.94 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 342.295 kN.
-. Vr = 3143.981 kN.
-. Ratio = Vu / Vr = 0.109 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 380.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 380.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-9.1025e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-8.4449e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-8.4449e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113123,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2670.27      -842.96      -697.55      -412.07      -340.98
           ------------------------------------------------------------------------------
            DL+LL+Others     2670.27      -842.96      -697.55      -412.07      -340.98
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      697.55 kN-m.
           -. End Moments (My2) =      842.96 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -842.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -842.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      340.98 kN-m.
          -. End Moments (Mz2) =      412.07 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -412.07 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -412.07 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12940.633 kN.
          -. Mry        =      4081.252 kN-m.
          -. Mrz        =      1991.097 kN-m.
          -. Mr         =      4541.044 kN-m.
          -. Pu/Pr      =   0.206  --->  O.K !
          -. Muy/Mry    =   0.207  --->  O.K !
          -. Muz/Mrz    =   0.207  --->  O.K !
          -. Mu/Mr      =   0.207  --->  O.K !
          -. Ratio      =   0.207  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2670.27 kN.
          -. Vuz    =        290.83 kN.
          -. Muy    =       -842.96 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.55 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.11

          -. Vuy    =        142.29 kN.
          -. Muz    =       -412.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.02
```

( ). Compute shear strength of concrete.
-. Vuz = 290.83 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1403.06 kN.
-. phiVcz = phi * Vcz = 1262.75 kN.

-. Vuy = 142.29 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1362.96 kN.
-. phiVcy = phi * Vcy = 1226.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2203.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5745.43 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2203.63 kN.
-. phiVsz = phi*Vsz = 1983.27 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2185.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5785.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2185.44 kN.
-. phiVsy = phi*Vsy = 1966.89 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 323.769 kN.
-. Vr = 3193.560 kN.
-. Ratio = Vu / Vr = 0.101 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 359.74 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 359.74 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113124,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2686.94      -697.55      -560.02      -340.98      -273.76
           ------------------------------------------------------------------------------
            DL+LL+Others     2686.94      -697.55      -560.02      -340.98      -273.76
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      560.02 kN-m.
           -. End Moments (My2) =      697.55 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -697.55 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -697.55 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      273.76 kN-m.
          -. End Moments (Mz2) =      340.98 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -340.98 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -340.98 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14955.920 kN.
          -. Mry        =      3861.315 kN-m.
          -. Mrz        =      1881.760 kN-m.
          -. Mr         =      4295.436 kN-m.
          -. Pu/Pr      =   0.180  --->  O.K !
          -. Muy/Mry    =   0.181  --->  O.K !
          -. Muz/Mrz    =   0.181  --->  O.K !
          -. Mu/Mr      =   0.181  --->  O.K !
          -. Ratio      =   0.181  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2686.94 kN.
          -. Vuz    =        275.07 kN.
          -. Muy    =       -697.55 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.36 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.19

          -. Vuy    =        134.53 kN.
          -. Muz    =       -340.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.56 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.10
```

( ). Compute shear strength of concrete.
-. Vuz = 275.07 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1439.44 kN.
-. phiVcz = phi * Vcz = 1295.50 kN.

-. Vuy = 134.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1400.21 kN.
-. phiVcy = phi * Vcy = 1260.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2219.44 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5709.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2219.44 kN.
-. phiVsz = phi*Vsz = 1997.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2202.37 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5748.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2202.37 kN.
-. phiVsy = phi*Vsy = 1982.13 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 306.203 kN.
-. Vr = 3242.322 kN.
-. Ratio = Vu / Vr = 0.094 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 340.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 340.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113125,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2703.61      -560.02      -430.95      -273.76      -210.69
           ------------------------------------------------------------------------------
            DL+LL+Others     2703.61      -560.02      -430.95      -273.76      -210.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      430.95 kN-m.
           -. End Moments (My2) =      560.02 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -560.02 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -560.02 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      210.69 kN-m.
          -. End Moments (Mz2) =      273.76 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -273.76 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -273.76 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17159.965 kN.
          -. Mry        =      3561.750 kN-m.
          -. Mrz        =      1735.790 kN-m.
          -. Mr         =      3962.200 kN-m.
          -. Pu/Pr      =   0.158  --->  O.K !
          -. Muy/Mry    =   0.157  --->  O.K !
          -. Muz/Mrz    =   0.158  --->  O.K !
          -. Mu/Mr      =   0.158  --->  O.K !
          -. Ratio      =   0.158  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2703.61 kN.
          -. Vuz    =        258.15 kN.
          -. Muy    =       -560.02 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.27

          -. Vuy    =        126.22 kN.
          -. Muz    =       -273.76 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.37 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.18
```

( ). Compute shear strength of concrete.
-. Vuz = 258.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1475.99 kN.
-. phiVcz = phi * Vcz = 1328.39 kN.

-. Vuy = 126.22 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1437.73 kN.
-. phiVcy = phi * Vcy = 1293.96 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2234.69 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5672.49 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2234.69 kN.
-. phiVsz = phi*Vsz = 2011.22 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2218.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5710.76 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2218.71 kN.
-. phiVsy = phi*Vsy = 1996.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 287.356 kN.
-. Vr = 3290.798 kN.
-. Ratio = Vu / Vr = 0.087 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 319.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 319.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113126,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2720.27      -430.95      -310.48      -210.69      -151.84
           ------------------------------------------------------------------------------
            DL+LL+Others     2720.27      -430.95      -310.48      -210.69      -151.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      310.48 kN-m.
           -. End Moments (My2) =      430.95 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -430.95 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -430.95 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      151.84 kN-m.
          -. End Moments (Mz2) =      210.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -210.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -210.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     19611.554 kN.
          -. Mry        =      3134.567 kN-m.
          -. Mrz        =      1541.285 kN-m.
          -. Mr         =      3493.003 kN-m.
          -. Pu/Pr      =   0.139  --->  O.K !
          -. Muy/Mry    =   0.137  --->  O.K !
          -. Muz/Mrz    =   0.137  --->  O.K !
          -. Mu/Mr      =   0.139  --->  O.K !
          -. Ratio      =   0.139  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2720.27 kN.
          -. Vuz    =        240.94 kN.
          -. Muy    =       -430.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.35

          -. Vuy    =        117.79 kN.
          -. Muz    =       -210.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.26
```

( ). Compute shear strength of concrete.
-. Vuz = 240.94 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1512.23 kN.
-. phiVcz = phi * Vcz = 1361.00 kN.

-. Vuy = 117.79 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1475.02 kN.
-. phiVcy = phi * Vcy = 1327.52 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2249.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5636.26 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2249.22 kN.
-. phiVsz = phi*Vsz = 2024.30 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2234.30 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5673.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2234.30 kN.
-. phiVsy = phi*Vsy = 2010.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 268.192 kN.
-. Vr = 3338.388 kN.
-. Ratio = Vu / Vr = 0.080 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 297.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 297.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113127,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2998.29      -199.05      -132.57      -205.08      -135.50
           ------------------------------------------------------------------------------
            DL+LL+Others     2998.29      -199.05      -132.57      -205.08      -135.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      132.57 kN-m.
           -. End Moments (My2) =      199.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -199.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -199.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      135.50 kN-m.
          -. End Moments (Mz2) =      205.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -205.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -205.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     23998.429 kN.
          -. Mry        =      1611.120 kN-m.
          -. Mrz        =      1654.677 kN-m.
          -. Mr         =      2309.472 kN-m.
          -. Pu/Pr      =   0.125  --->  O.K !
          -. Muy/Mry    =   0.124  --->  O.K !
          -. Muz/Mrz    =   0.124  --->  O.K !
          -. Mu/Mr      =   0.125  --->  O.K !
          -. Ratio      =   0.125  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2736.94 kN.
          -. Vuz    =        207.74 kN.
          -. Muy    =       -310.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.43

          -. Vuy    =        101.55 kN.
          -. Muz    =       -151.84 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.36
```

( ). Compute shear strength of concrete.
-. Vuz = 207.74 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1551.76 kN.
-. phiVcz = phi * Vcz = 1396.58 kN.

-. Vuy = 101.55 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1515.83 kN.
-. phiVcy = phi * Vcy = 1364.25 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2264.45 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5596.73 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2264.45 kN.
-. phiVsz = phi*Vsz = 2038.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2250.64 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5632.65 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2250.64 kN.
-. phiVsy = phi*Vsy = 2025.58 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 231.235 kN.
-. Vr = 3389.824 kN.
-. Ratio = Vu / Vr = 0.068 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 256.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 256.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113128,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3031.62      -132.57       -81.04      -135.50       -82.10
           ------------------------------------------------------------------------------
            DL+LL+Others     3031.62      -132.57       -81.04      -135.50       -82.10
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       81.04 kN-m.
           -. End Moments (My2) =      132.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -81.04 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -81.04 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       82.10 kN-m.
          -. End Moments (Mz2) =      135.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -82.10 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -82.10 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       652.393 kN-m.
          -. Mrz        =       660.909 kN-m.
          -. Mr         =       928.664 kN-m.
          -. Pu/Pr      =   0.124  --->  O.K !
          -. Muy/Mry    =   0.124  --->  O.K !
          -. Muz/Mrz    =   0.124  --->  O.K !
          -. Mu/Mr      =   0.124  --->  O.K !
          -. Ratio      =   0.124  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2753.60 kN.
          -. Vuz    =        160.86 kN.
          -. Muy    =       -206.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.52

          -. Vuy    =         78.64 kN.
          -. Muz    =       -101.10 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.45
```

( ). Compute shear strength of concrete.
-. Vuz = 160.86 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1591.98 kN.
-. phiVcz = phi * Vcz = 1432.79 kN.

-. Vuy = 78.64 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1557.48 kN.
-. phiVcy = phi * Vcy = 1401.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2279.32 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5556.50 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2279.32 kN.
-. phiVsz = phi*Vsz = 2051.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2266.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5591.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2266.60 kN.
-. phiVsy = phi*Vsy = 2039.94 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 179.057 kN.
-. Vr = 3441.670 kN.
-. Ratio = Vu / Vr = 0.052 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 198.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 198.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113129,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3048.28       -81.04       -43.34       -82.10       -43.47
           ------------------------------------------------------------------------------
            DL+LL+Others     3048.28       -81.04       -43.34       -82.10       -43.47
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       43.34 kN-m.
           -. End Moments (My2) =       81.04 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -43.34 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -43.34 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       43.47 kN-m.
          -. End Moments (Mz2) =       82.10 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -43.47 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -43.47 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       347.054 kN-m.
          -. Mrz        =       347.969 kN-m.
          -. Mr         =       491.456 kN-m.
          -. Pu/Pr      =   0.125  --->  O.K !
          -. Muy/Mry    =   0.125  --->  O.K !
          -. Muz/Mrz    =   0.125  --->  O.K !
          -. Mu/Mr      =   0.125  --->  O.K !
          -. Ratio      =   0.125  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2770.26 kN.
          -. Vuz    =        117.55 kN.
          -. Muy    =       -126.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.60

          -. Vuy    =         57.51 kN.
          -. Muz    =        -61.81 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.53
```

( ). Compute shear strength of concrete.
-. Vuz = 117.55 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1626.02 kN.
-. phiVcz = phi * Vcz = 1463.42 kN.

-. Vuy = 57.51 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1592.82 kN.
-. phiVcy = phi * Vcy = 1433.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2291.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5522.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2291.42 kN.
-. phiVsz = phi*Vsz = 2062.28 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2279.62 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5555.67 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2279.62 kN.
-. phiVsy = phi*Vsy = 2051.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 130.869 kN.
-. Vr = 3485.189 kN.
-. Ratio = Vu / Vr = 0.038 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 145.41 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 145.41 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113130,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3064.95       -43.34       -18.18       -43.47       -18.02
           ------------------------------------------------------------------------------
            DL+LL+Others     3064.95       -43.34       -18.18       -43.47       -18.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       18.18 kN-m.
           -. End Moments (My2) =       43.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -18.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -18.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       18.02 kN-m.
          -. End Moments (Mz2) =       43.47 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -18.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -18.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       144.827 kN-m.
          -. Mrz        =       143.439 kN-m.
          -. Mr         =       203.837 kN-m.
          -. Pu/Pr      =   0.126  --->  O.K !
          -. Muy/Mry    =   0.126  --->  O.K !
          -. Muz/Mrz    =   0.126  --->  O.K !
          -. Mu/Mr      =   0.126  --->  O.K !
          -. Ratio      =   0.126  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2803.58 kN.
          -. Vuz    =         78.34 kN.
          -. Muy    =        -28.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.65

          -. Vuy    =         38.38 kN.
          -. Muz    =        -13.89 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.58
```

( ). Compute shear strength of concrete.
-. Vuz = 78.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1651.22 kN.
-. phiVcz = phi * Vcz = 1486.10 kN.

-. Vuy = 38.38 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1619.03 kN.
-. phiVcy = phi * Vcy = 1457.13 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2300.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5497.27 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2300.12 kN.
-. phiVsz = phi*Vsz = 2070.11 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2288.97 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5529.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2288.97 kN.
-. phiVsy = phi*Vsy = 2060.07 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 87.235 kN.
-. Vr = 3517.200 kN.
-. Ratio = Vu / Vr = 0.025 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 96.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 96.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113131,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3081.61       -18.18        -4.20       -18.02        -4.09
           ------------------------------------------------------------------------------
            DL+LL+Others     3081.61       -18.18        -4.20       -18.02        -4.09
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.20 kN-m.
           -. End Moments (My2) =       18.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.20 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.20 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.09 kN-m.
          -. End Moments (Mz2) =       18.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.09 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.09 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        33.274 kN-m.
          -. Mrz        =        32.381 kN-m.
          -. Mr         =        46.429 kN-m.
          -. Pu/Pr      =   0.126  --->  O.K !
          -. Muy/Mry    =   0.126  --->  O.K !
          -. Muz/Mrz    =   0.126  --->  O.K !
          -. Mu/Mr      =   0.126  --->  O.K !
          -. Ratio      =   0.126  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2820.24 kN.
          -. Vuz    =         43.46 kN.
          -. Muy    =         -6.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.69

          -. Vuy    =         21.35 kN.
          -. Muz    =         -3.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.62
```

( ). Compute shear strength of concrete.
-. Vuz = 43.46 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1668.72 kN.
-. phiVcz = phi * Vcz = 1501.85 kN.

-. Vuy = 21.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1637.27 kN.
-. phiVcy = phi * Vcy = 1473.54 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2306.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5479.77 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2306.04 kN.
-. phiVsz = phi*Vsz = 2075.44 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2295.33 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5511.22 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2295.33 kN.
-. phiVsy = phi*Vsy = 2065.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 48.423 kN.
-. Vr = 3539.343 kN.
-. Ratio = Vu / Vr = 0.014 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 53.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 53.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113132,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3098.27        -4.20         0.00        -4.09         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3098.27        -4.20         0.00        -4.09         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        4.20 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        4.09 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.127  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.127  --->  O.K !
          -. Ratio      =   0.127  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2836.90 kN.
          -. Vuz    =         13.02 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.45 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.66

          -. Vuy    =          6.43 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.45 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.66
```

( ). Compute shear strength of concrete.
-. Vuz = 13.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1653.25 kN.
-. phiVcz = phi * Vcz = 1487.93 kN.

-. Vuy = 6.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1653.25 kN.
-. phiVcy = phi * Vcy = 1487.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2300.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5495.23 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2300.82 kN.
-. phiVsz = phi*Vsz = 2070.74 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2300.82 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5495.23 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2300.82 kN.
-. phiVsy = phi*Vsy = 2070.74 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 14.522 kN.
-. Vr = 3558.665 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 16.14 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 16.14 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113202,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2646.78      -310.84      -157.85      -144.12      -386.30
           ------------------------------------------------------------------------------
            DL+LL+Others     2646.78      -310.84      -157.85      -144.12      -386.30
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      157.85 kN-m.
           -. End Moments (My2) =      310.84 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -157.85 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -157.85 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      144.12 kN-m.
          -. End Moments (Mz2) =      386.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -386.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -386.30 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     20600.474 kN.
          -. Mry        =      1240.869 kN-m.
          -. Mrz        =      3023.672 kN-m.
          -. Mr         =      3268.386 kN-m.
          -. Pu/Pr      =   0.128  --->  O.K !
          -. Muy/Mry    =   0.127  --->  O.K !
          -. Muz/Mrz    =   0.128  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2352.82 kN.
          -. Vuz    =       1077.02 kN.
          -. Muy    =       -219.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        383.52 kN.
          -. Muz    =       -340.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 1077.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1284.44 kN.
-. phiVcz = phi * Vcz = 1156.00 kN.

-. Vuy = 383.52 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1242.24 kN.
-. phiVcy = phi * Vcy = 1118.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2147.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5864.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2147.24 kN.
-. phiVsz = phi*Vsz = 1932.52 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2125.16 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5906.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2125.16 kN.
-. phiVsy = phi*Vsy = 1912.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1143.266 kN.
-. Vr = 3030.661 kN.
-. Ratio = Vu / Vr = 0.377 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1270.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1270.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-9.6895e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-9.6895e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113203,  LCB = 151-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2369.53      -219.34      -668.59      -340.01      -480.10
           ------------------------------------------------------------------------------
            DL+LL+Others     2369.53      -219.34      -668.59      -340.01      -480.10
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      219.34 kN-m.
           -. End Moments (My2) =      668.59 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -668.59 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -668.59 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      340.01 kN-m.
          -. End Moments (Mz2) =      480.10 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -480.10 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -480.10 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12968.283 kN.
          -. Mry        =      3689.435 kN-m.
          -. Mrz        =      2648.420 kN-m.
          -. Mr         =      4541.592 kN-m.
          -. Pu/Pr      =   0.183  --->  O.K !
          -. Muy/Mry    =   0.181  --->  O.K !
          -. Muz/Mrz    =   0.181  --->  O.K !
          -. Mu/Mr      =   0.183  --->  O.K !
          -. Ratio      =   0.183  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2369.53 kN.
          -. Vuz    =        953.34 kN.
          -. Muy    =       -668.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.93

          -. Vuy    =        334.92 kN.
          -. Muz    =       -480.10 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.22 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 953.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1324.56 kN.
-. phiVcz = phi * Vcz = 1192.11 kN.

-. Vuy = 334.92 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1282.95 kN.
-. phiVcy = phi * Vcy = 1154.66 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2167.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5823.92 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2167.20 kN.
-. phiVsz = phi*Vsz = 1950.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2146.48 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5865.53 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2146.48 kN.
-. phiVsy = phi*Vsy = 1931.83 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1010.454 kN.
-. Vr = 3086.491 kN.
-. Ratio = Vu / Vr = 0.327 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1122.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1122.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113204,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            289.40       677.54      1071.85       568.93       678.49
           ------------------------------------------------------------------------------
            DL+LL+Others      289.40       677.54      1071.85       568.93       678.49
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      677.54 kN-m.
           -. End Moments (My2) =     1071.85 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1071.85 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1071.85 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      568.93 kN-m.
          -. End Moments (Mz2) =      678.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      678.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      678.49 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1149.102 kN.
          -. Mry        =      4280.319 kN-m.
          -. Mrz        =      2720.269 kN-m.
          -. Mr         =      5071.587 kN-m.
          -. Pu/Pr      =   0.252  --->  O.K !
          -. Muy/Mry    =   0.250  --->  O.K !
          -. Muz/Mrz    =   0.249  --->  O.K !
          -. Mu/Mr      =   0.252  --->  O.K !
          -. Ratio      =   0.252  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2386.24 kN.
          -. Vuz    =        829.36 kN.
          -. Muy    =      -1060.13 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        286.65 kN.
          -. Muz    =       -611.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 829.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1280.83 kN.
-. phiVcz = phi * Vcz = 1152.75 kN.

-. Vuy = 286.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1238.58 kN.
-. phiVcy = phi * Vcy = 1114.72 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2145.40 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5867.66 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2145.40 kN.
-. phiVsz = phi*Vsz = 1930.86 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.19 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5909.91 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.19 kN.
-. phiVsy = phi*Vsy = 1910.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 877.499 kN.
-. Vr = 3025.592 kN.
-. Ratio = Vu / Vr = 0.290 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 975.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 975.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113205,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            301.34      1071.85      1407.38       678.49       773.87
           ---------------------------------------------------------------------------
            DL+LL+Others      301.34      1071.85      1407.38       678.49       773.87
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1071.85 kN-m.
           -. End Moments (My2) =     1407.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1407.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1407.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      678.49 kN-m.
          -. End Moments (Mz2) =      773.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      773.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      773.87 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       943.736 kN.
          -. Mry        =      4428.995 kN-m.
          -. Mrz        =      2435.367 kN-m.
          -. Mr         =      5054.405 kN-m.
          -. Pu/Pr      =   0.319  --->  O.K !
          -. Muy/Mry    =   0.318  --->  O.K !
          -. Muz/Mrz    =   0.318  --->  O.K !
          -. Mu/Mr      =   0.319  --->  O.K !
          -. Ratio      =   0.319  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2402.94 kN.
          -. Vuz    =        706.22 kN.
          -. Muy    =      -1393.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75

          -. Vuy    =        239.18 kN.
          -. Muz    =       -726.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65
```

( ). Compute shear strength of concrete.
-. Vuz = 706.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1240.24 kN.
-. phiVcz = phi * Vcz = 1116.22 kN.

-. Vuy = 239.18 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1197.52 kN.
-. phiVcy = phi * Vcy = 1077.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2124.09 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5908.25 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2124.09 kN.
-. phiVsz = phi*Vsz = 1911.68 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2100.46 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5950.97 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2100.46 kN.
-. phiVsy = phi*Vsy = 1890.41 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 745.627 kN.
-. Vr = 2968.181 kN.
-. Ratio = Vu / Vr = 0.251 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 828.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 828.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0026 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113206,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            313.29      1407.38      1684.77       773.87       851.35
           ------------------------------------------------------------------------------
            DL+LL+Others      313.29      1407.38      1684.77       773.87       851.35
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1407.38 kN-m.
           -. End Moments (My2) =     1684.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1684.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1684.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      773.87 kN-m.
          -. End Moments (Mz2) =      851.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      851.35 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      851.35 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       838.842 kN.
          -. Mry        =      4504.419 kN-m.
          -. Mrz        =      2274.576 kN-m.
          -. Mr         =      5046.136 kN-m.
          -. Pu/Pr      =   0.373  --->  O.K !
          -. Muy/Mry    =   0.374  --->  O.K !
          -. Muz/Mrz    =   0.374  --->  O.K !
          -. Mu/Mr      =   0.374  --->  O.K !
          -. Ratio      =   0.374  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2419.64 kN.
          -. Vuz    =        585.17 kN.
          -. Muy    =      -1668.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.68

          -. Vuy    =        193.07 kN.
          -. Muz    =       -821.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.59
```

( ). Compute shear strength of concrete.
-. Vuz = 585.17 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1210.88 kN.
-. phiVcz = phi * Vcz = 1089.79 kN.

-. Vuy = 193.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1167.90 kN.
-. phiVcy = phi * Vcy = 1051.11 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2107.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5937.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2107.99 kN.
-. phiVsz = phi*Vsz = 1897.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2083.30 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5980.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2083.30 kN.
-. phiVsy = phi*Vsy = 1874.97 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 616.195 kN.
-. Vr = 2926.078 kN.
-. Ratio = Vu / Vr = 0.211 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 684.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 684.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113207,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            325.24      1684.77      1904.97       851.35       909.96
           ------------------------------------------------------------------------------
            DL+LL+Others      325.24      1684.77      1904.97       851.35       909.96
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1684.77 kN-m.
           -. End Moments (My2) =     1904.97 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1904.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1904.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      851.35 kN-m.
          -. End Moments (Mz2) =      909.96 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      909.96 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      909.96 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =       781.702 kN.
           -. Mry        =      4549.705 kN-m.
           -. Mrz        =      2170.775 kN-m.
           -. Mr         =      5041.040 kN-m.
           -. Pu/Pr      =   0.416  --->  O.K !
           -. Muy/Mry    =   0.419  --->  O.K !
           -. Muz/Mrz    =   0.419  --->  O.K !
           -. Mu/Mr      =   0.419  --->  O.K !
           -. Ratio      =   0.419  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2436.34 kN.
           -. Vuz    =        467.37 kN.
           -. Muy    =      -1887.76 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  32.83 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.64

           -. Vuy    =        148.87 kN.
           -. Muz    =       -895.96 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  33.15 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 467.37 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1191.28 kN.
-. phiVcz = phi * Vcz = 1072.15 kN.

-. Vuy = 148.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1148.16 kN.
-. phiVcy = phi * Vcy = 1033.35 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2096.90 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5957.20 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2096.90 kN.
-. phiVsz = phi*Vsz = 1887.21 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2071.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6000.32 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2071.49 kN.
-. phiVsy = phi*Vsy = 1864.34 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 490.502 kN.
-. Vr = 2897.688 kN.
-. Ratio = Vu / Vr = 0.169 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 545.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 545.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113208,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            337.19      1904.97      2077.51       909.96       949.32
           ------------------------------------------------------------------------------
            DL+LL+Others      337.19      1904.97      2077.51       909.96       949.32
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1904.97 kN-m.
           -. End Moments (My2) =     2077.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2077.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2077.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      909.96 kN-m.
          -. End Moments (Mz2) =      949.32 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      949.32 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      949.32 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       738.364 kN.
          -. Mry        =      4583.033 kN-m.
          -. Mrz        =      2090.307 kN-m.
          -. Mr         =      5037.219 kN-m.
          -. Pu/Pr      =   0.457  --->  O.K !
          -. Muy/Mry    =   0.453  --->  O.K !
          -. Muz/Mrz    =   0.454  --->  O.K !
          -. Mu/Mr      =   0.457  --->  O.K !
          -. Ratio      =   0.457  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2453.04 kN.
          -. Vuz    =        354.02 kN.
          -. Muy    =      -2059.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.61

          -. Vuy    =        107.32 kN.
          -. Muz    =       -949.28 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.24 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51
```

( ). Compute shear strength of concrete.
-. Vuz = 354.02 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1179.20 kN.
-. phiVcz = phi * Vcz = 1061.28 kN.

-. Vuy = 107.32 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1136.01 kN.
-. phiVcy = phi * Vcy = 1022.41 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2089.93 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5969.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2089.93 kN.
-. phiVsz = phi*Vsz = 1880.93 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2064.06 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6012.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2064.06 kN.
-. phiVsy = phi*Vsy = 1857.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 369.928 kN.
-. Vr = 2880.071 kN.
-. Ratio = Vu / Vr = 0.128 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 411.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 411.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113209,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            349.14      2077.51      2200.05       949.32       973.69
           ------------------------------------------------------------------------------
            DL+LL+Others      349.14      2077.51      2200.05       949.32       973.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2077.51 kN-m.
           -. End Moments (My2) =     2200.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2200.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2200.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      949.32 kN-m.
          -. End Moments (Mz2) =      973.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      973.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      973.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       727.463 kN.
          -. Mry        =      4607.387 kN-m.
          -. Mrz        =      2033.645 kN-m.
          -. Mr         =      5036.241 kN-m.
          -. Pu/Pr      =   0.480  --->  O.K !
          -. Muy/Mry    =   0.478  --->  O.K !
          -. Muz/Mrz    =   0.479  --->  O.K !
          -. Mu/Mr      =   0.480  --->  O.K !
          -. Ratio      =   0.480  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2469.74 kN.
          -. Vuz    =        246.27 kN.
          -. Muy    =      -2181.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.95 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.60

          -. Vuy    =         69.64 kN.
          -. Muz    =       -985.68 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.28 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.50
```

( ). Compute shear strength of concrete.
-. Vuz = 246.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1174.09 kN.
-. phiVcz = phi * Vcz = 1056.68 kN.

-. Vuy = 69.64 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1130.88 kN.
-. phiVcy = phi * Vcy = 1017.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2086.94 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5974.39 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2086.94 kN.
-. phiVsz = phi*Vsz = 1878.25 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2060.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6017.61 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2060.89 kN.
-. phiVsy = phi*Vsy = 1854.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 255.927 kN.
-. Vr = 2872.588 kN.
-. Ratio = Vu / Vr = 0.089 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 284.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 284.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113210,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            361.09      2200.05      2272.48       973.69       981.02
           ---------------------------------------------------------------------------
            DL+LL+Others      361.09      2200.05      2272.48       973.69       981.02
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2200.05 kN-m.
           -. End Moments (My2) =     2272.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2272.48 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2272.48 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      973.69 kN-m.
          -. End Moments (Mz2) =      981.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      981.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      981.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       729.709 kN.
          -. Mry        =      4626.430 kN-m.
          -. Mrz        =      1990.401 kN-m.
          -. Mr         =      5036.422 kN-m.
          -. Pu/Pr      =   0.495  --->  O.K !
          -. Muy/Mry    =   0.491  --->  O.K !
          -. Muz/Mrz    =   0.493  --->  O.K !
          -. Mu/Mr      =   0.495  --->  O.K !
          -. Ratio      =   0.495  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2486.44 kN.
          -. Vuz    =        145.23 kN.
          -. Muy    =      -2253.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.60

          -. Vuy    =         38.93 kN.
          -. Muz    =      -1003.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.27 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51
```

( ). Compute shear strength of concrete.
-. Vuz = 145.23 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1175.70 kN.
-. phiVcz = phi * Vcz = 1058.13 kN.

-. Vuy = 38.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1132.49 kN.
-. phiVcy = phi * Vcy = 1019.24 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2087.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5972.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2087.88 kN.
-. phiVsz = phi*Vsz = 1879.09 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2061.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6016.00 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2061.89 kN.
-. phiVsy = phi*Vsy = 1855.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 150.359 kN.
-. Vr = 2874.935 kN.
-. Ratio = Vu / Vr = 0.052 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 167.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 167.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113211,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            373.04      2272.48      2290.65       981.02       971.12
           ------------------------------------------------------------------------------
            DL+LL+Others      373.04      2272.48      2290.65       981.02       971.12
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2272.48 kN-m.
           -. End Moments (My2) =     2290.65 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2290.65 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2290.65 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      971.12 kN-m.
          -. End Moments (Mz2) =      981.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      971.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      971.12 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       760.368 kN.
          -. Mry        =      4642.188 kN-m.
          -. Mrz        =      1960.101 kN-m.
          -. Mr         =      5039.039 kN-m.
          -. Pu/Pr      =   0.491  --->  O.K !
          -. Muy/Mry    =   0.493  --->  O.K !
          -. Muz/Mrz    =   0.495  --->  O.K !
          -. Mu/Mr      =   0.495  --->  O.K !
          -. Ratio      =   0.495  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        373.04 kN.
          -. Vuz    =         37.24 kN.
          -. Muy    =       2290.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.14 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.87

          -. Vuy    =         45.06 kN.
          -. Muz    =        971.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 37.24 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1296.34 kN.
-. phiVcz = phi * Vcz = 1166.71 kN.

-. Vuy = 45.06 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1296.34 kN.
-. phiVcy = phi * Vcy = 1166.71 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2153.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5852.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2153.26 kN.
-. phiVsz = phi*Vsz = 1937.94 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2153.26 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5852.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2153.26 kN.
-. phiVsy = phi*Vsy = 1937.94 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 58.459 kN.
-. Vr = 3104.643 kN.
-. Ratio = Vu / Vr = 0.019 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 64.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 64.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0073 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0073 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0073 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113212,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            373.01      2290.65      2245.26       971.12       938.50
           ------------------------------------------------------------------------------
            DL+LL+Others      373.01      2290.65      2245.26       971.12       938.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2245.26 kN-m.
           -. End Moments (My2) =     2290.65 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2290.65 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2290.65 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      938.50 kN-m.
          -. End Moments (Mz2) =      971.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      971.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      971.12 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       760.368 kN.
          -. Mry        =      4642.188 kN-m.
          -. Mrz        =      1960.101 kN-m.
          -. Mr         =      5039.039 kN-m.
          -. Pu/Pr      =   0.491  --->  O.K !
          -. Muy/Mry    =   0.493  --->  O.K !
          -. Muz/Mrz    =   0.495  --->  O.K !
          -. Mu/Mr      =   0.495  --->  O.K !
          -. Ratio      =   0.495  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2503.17 kN.
          -. Vuz    =         97.92 kN.
          -. Muy    =      -2271.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.60

          -. Vuy    =         65.80 kN.
          -. Muz    =      -1001.26 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.51
```

( ). Compute shear strength of concrete.
-. Vuz = 97.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1176.39 kN.
-. phiVcz = phi * Vcz = 1058.75 kN.

-. Vuy = 65.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1133.18 kN.
-. phiVcy = phi * Vcy = 1019.87 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2088.29 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5972.10 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2088.29 kN.
-. phiVsz = phi*Vsz = 1879.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2062.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6015.30 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2062.32 kN.
-. phiVsy = phi*Vsy = 1856.09 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 117.975 kN.
-. Vr = 2875.951 kN.
-. Ratio = Vu / Vr = 0.041 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 131.08 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 131.08 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113213,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            384.96      2245.26      2200.49       938.50       906.26
           ------------------------------------------------------------------------------
            DL+LL+Others      384.96      2245.26      2200.49       938.50       906.26
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2200.49 kN-m.
           -. End Moments (My2) =     2245.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2245.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2245.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      906.26 kN-m.
          -. End Moments (Mz2) =      938.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      938.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      938.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       803.058 kN.
          -. Mry        =      4655.734 kN-m.
          -. Mrz        =      1937.206 kN-m.
          -. Mr         =      5042.680 kN-m.
          -. Pu/Pr      =   0.479  --->  O.K !
          -. Muy/Mry    =   0.482  --->  O.K !
          -. Muz/Mrz    =   0.484  --->  O.K !
          -. Mu/Mr      =   0.484  --->  O.K !
          -. Ratio      =   0.484  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2519.86 kN.
          -. Vuz    =         96.67 kN.
          -. Muy    =      -2227.16 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62

          -. Vuy    =         65.36 kN.
          -. Muz    =       -974.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.52
```

( ). Compute shear strength of concrete.
-. Vuz = 96.67 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1183.16 kN.
-. phiVcz = phi * Vcz = 1064.84 kN.

-. Vuy = 65.36 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1139.99 kN.
-. phiVcy = phi * Vcy = 1025.99 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2092.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5965.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2092.22 kN.
-. phiVsz = phi*Vsz = 1883.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2066.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6008.50 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2066.51 kN.
-. phiVsy = phi*Vsy = 1859.86 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 116.697 kN.
-. Vr = 2885.846 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 129.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 129.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113214,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            396.92      2200.49      2156.21       906.26       874.36
           ------------------------------------------------------------------------------
            DL+LL+Others      396.92      2200.49      2156.21       906.26       874.36
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2156.21 kN-m.
           -. End Moments (My2) =     2200.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2200.49 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2200.49 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      874.36 kN-m.
          -. End Moments (Mz2) =      906.26 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      906.26 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      906.26 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       841.403 kN.
          -. Mry        =      4669.138 kN-m.
          -. Mrz        =      1913.328 kN-m.
          -. Mr         =      5045.956 kN-m.
          -. Pu/Pr      =   0.472  --->  O.K !
          -. Muy/Mry    =   0.471  --->  O.K !
          -. Muz/Mrz    =   0.474  --->  O.K !
          -. Mu/Mr      =   0.474  --->  O.K !
          -. Ratio      =   0.474  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2536.54 kN.
          -. Vuz    =         95.69 kN.
          -. Muy    =      -2183.03 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =         65.04 kN.
          -. Muz    =       -947.14 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

```
( ). Compute shear strength of concrete.
     -. Vuz       =       95.69 kN.
     -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1189.85 kN.
     -. phiVcz    = phi * Vcz =     1070.87 kN.

     -. Vuy       =       65.04 kN.
     -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1146.73 kN.
     -. phiVcy    = phi * Vcy =     1032.05 kN.

( ). Compute maximum spacing of ties.
     -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
     -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
     -. Applied spacing s_z   =    0.150 m.

     -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
     -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
     -. Applied spacing s_y   =    0.150 m.

     -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

( ). Compute shear strength of reinforcement.
     -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2096.08 kN.
     -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5958.63 kN.
     -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2096.08 kN.
     -. phiVsz   = phi*Vsz =     1886.47 kN.
     -. phiVsz > (Vuz-phiVcz)  --->  O.K !
     -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

     -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2070.62 kN.
     -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6001.76 kN.
     -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2070.62 kN.
     -. phiVsy   = phi*Vsy =     1863.56 kN.
     -. phiVsy > (Vuy-phiVcy)  --->  O.K !
     -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

     -. Vu       =     115.700 kN.
     -. Vr       =    2895.609 kN.
     -. Ratio    = Vu / Vr = 0.040  --->  O.K !

( ). Compute minimum longitudinal reinforcement by shear.
     -. phia     =   0.75
     -. phib     =   0.90
     -. phiv     =   0.90
     -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =      128.56 kN.
     -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =      128.56 kN.
     -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy =
0.0035 m^2.
     -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy =
0.0036 m^2.
     -. As_req  =  MAX[ Asy_req, Asz_req ] =   0.0036 m^2.
     -. As      =   0.0363 m^2.
     -. As_req < As  --->  O.K !
```

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113215,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            408.89      2156.21      2061.43       874.36       825.52
           ---------------------------------------------------------------------------
            DL+LL+Others      408.89      2156.21      2061.43       874.36       825.52
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2061.43 kN-m.
           -. End Moments (My2) =     2156.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2156.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2156.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      825.52 kN-m.
          -. End Moments (Mz2) =      874.36 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      874.36 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      874.36 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       886.653 kN.
          -. Mry        =      4673.888 kN-m.
          -. Mrz        =      1896.165 kN-m.
          -. Mr         =      5043.875 kN-m.
          -. Pu/Pr      =   0.461  --->  O.K !
          -. Muy/Mry    =   0.461  --->  O.K !
          -. Muz/Mrz    =   0.461  --->  O.K !
          -. Mu/Mr      =   0.461  --->  O.K !
          -. Ratio      =   0.461  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2553.23 kN.
          -. Vuz    =        191.33 kN.
          -. Muy    =      -2139.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62

          -. Vuy    =         98.03 kN.
          -. Muz    =       -920.61 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.52
```

( ). Compute shear strength of concrete.
-. Vuz = 191.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1183.52 kN.
-. phiVcz = phi * Vcz = 1065.17 kN.

-. Vuy = 98.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1140.35 kN.
-. phiVcy = phi * Vcy = 1026.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2092.43 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5964.97 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2092.43 kN.
-. phiVsz = phi*Vsz = 1883.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2066.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6008.13 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2066.73 kN.
-. phiVsy = phi*Vsy = 1860.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 214.980 kN.
-. Vr = 2886.376 kN.
-. Ratio = Vu / Vr = 0.074 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 238.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 238.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113216,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            420.85      2061.43      1926.89       825.52       763.84
           ---------------------------------------------------------------------------
            DL+LL+Others      420.85      2061.43      1926.89       825.52       763.84
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1926.89 kN-m.
           -. End Moments (My2) =     2061.43 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2061.43 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2061.43 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      763.84 kN-m.
          -. End Moments (Mz2) =      825.52 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      825.52 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      825.52 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       961.325 kN.
          -. Mry        =      4688.089 kN-m.
          -. Mrz        =      1877.731 kN-m.
          -. Mr         =      5050.154 kN-m.
          -. Pu/Pr      =   0.438  --->  O.K !
          -. Muy/Mry    =   0.440  --->  O.K !
          -. Muz/Mrz    =   0.440  --->  O.K !
          -. Mu/Mr      =   0.440  --->  O.K !
          -. Ratio      =   0.440  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2569.92 kN.
          -. Vuz    =        266.75 kN.
          -. Muy    =      -2045.56 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =        124.70 kN.
          -. Muz    =       -874.50 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53
```

( ). Compute shear strength of concrete.
-. Vuz = 266.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1187.77 kN.
-. phiVcz = phi * Vcz = 1069.00 kN.

-. Vuy = 124.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1144.63 kN.
-. phiVcy = phi * Vcy = 1030.17 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2094.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5960.71 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2094.89 kN.
-. phiVsz = phi*Vsz = 1885.40 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2069.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6003.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2069.34 kN.
-. phiVsy = phi*Vsy = 1862.41 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 294.457 kN.
-. Vr = 2892.580 kN.
-. Ratio = Vu / Vr = 0.102 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 327.17 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 327.17 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0034 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113217,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            432.81      1926.89      1763.09       763.84       693.32
           ---------------------------------------------------------------------------
            DL+LL+Others      432.81      1926.89      1763.09       763.84       693.32
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1763.09 kN-m.
           -. End Moments (My2) =     1926.89 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1926.89 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1926.89 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      693.32 kN-m.
          -. End Moments (Mz2) =      763.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      763.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      763.84 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1059.771 kN.
          -. Mry        =      4702.378 kN-m.
          -. Mrz        =      1864.133 kN-m.
          -. Mr         =      5058.394 kN-m.
          -. Pu/Pr      =   0.408  --->  O.K !
          -. Muy/Mry    =   0.410  --->  O.K !
          -. Muz/Mrz    =   0.410  --->  O.K !
          -. Mu/Mr      =   0.410  --->  O.K !
          -. Ratio      =   0.410  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2586.60 kN.
          -. Vuz    =        324.87 kN.
          -. Muy    =      -1912.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.66

          -. Vuy    =        144.68 kN.
          -. Muz    =       -813.23 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.07 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56
```

( ). Compute shear strength of concrete.
-. Vuz = 324.87 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1200.88 kN.
-. phiVcz = phi * Vcz = 1080.79 kN.

-. Vuy = 144.68 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1157.83 kN.
-. phiVcy = phi * Vcy = 1042.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2102.37 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5947.60 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2102.37 kN.
-. phiVsz = phi*Vsz = 1892.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2077.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5990.66 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2077.31 kN.
-. phiVsy = phi*Vsy = 1869.58 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 355.628 kN.
-. Vr = 2911.623 kN.
-. Ratio = Vu / Vr = 0.122 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 395.14 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 395.14 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113218,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            444.78      1763.09      1591.76       693.32       620.84
           ------------------------------------------------------------------------------
            DL+LL+Others      444.78      1763.09      1591.76       693.32       620.84
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1591.76 kN-m.
           -. End Moments (My2) =     1763.09 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1763.09 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1763.09 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      620.84 kN-m.
          -. End Moments (Mz2) =      693.32 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      693.32 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      693.32 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1181.288 kN.
          -. Mry        =      4716.893 kN-m.
          -. Mrz        =      1854.875 kN-m.
          -. Mr         =      5068.494 kN-m.
          -. Pu/Pr      =   0.377  --->  O.K !
          -. Muy/Mry    =   0.374  --->  O.K !
          -. Muz/Mrz    =   0.374  --->  O.K !
          -. Mu/Mr      =   0.377  --->  O.K !
          -. Ratio      =   0.377  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2603.28 kN.
          -. Vuz    =        339.85 kN.
          -. Muy    =      -1749.79 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71

          -. Vuy    =        149.84 kN.
          -. Muz    =       -741.11 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.62
```

( ). Compute shear strength of concrete.
-. Vuz = 339.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1225.37 kN.
-. phiVcz = phi * Vcz = 1102.83 kN.

-. Vuy = 149.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1182.51 kN.
-. phiVcy = phi * Vcy = 1064.26 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2116.01 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5923.12 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2116.01 kN.
-. phiVsz = phi*Vsz = 1904.41 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2091.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5965.98 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2091.84 kN.
-. phiVsy = phi*Vsy = 1882.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 371.413 kN.
-. Vr = 2946.918 kN.
-. Ratio = Vu / Vr = 0.126 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 412.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 412.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0025 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0025 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113219,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            456.75      1591.76      1417.80       620.84       547.95
           ------------------------------------------------------------------------------
            DL+LL+Others      456.75      1591.76      1417.80       620.84       547.95
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1417.80 kN-m.
           -. End Moments (My2) =     1591.76 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1591.76 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1591.76 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      547.95 kN-m.
          -. End Moments (Mz2) =      620.84 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      620.84 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      620.84 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1348.724 kN.
          -. Mry        =      4734.806 kN-m.
          -. Mrz        =      1846.919 kN-m.
          -. Mr         =      5082.273 kN-m.
          -. Pu/Pr      =   0.339  --->  O.K !
          -. Muy/Mry    =   0.336  --->  O.K !
          -. Muz/Mrz    =   0.336  --->  O.K !
          -. Mu/Mr      =   0.339  --->  O.K !
          -. Ratio      =   0.339  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2619.96 kN.
          -. Vuz    =        345.11 kN.
          -. Muy    =      -1579.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.41 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.77

          -. Vuy    =        151.36 kN.
          -. Muz    =       -666.38 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.68
```

( ). Compute shear strength of concrete.
-. Vuz = 345.11 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1253.68 kN.
-. phiVcz = phi * Vcz = 1128.31 kN.

-. Vuy = 151.36 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1211.10 kN.
-. phiVcy = phi * Vcy = 1089.99 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2131.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5894.81 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2131.26 kN.
-. phiVsz = phi*Vsz = 1918.14 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2108.11 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5937.39 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2108.11 kN.
-. phiVsy = phi*Vsy = 1897.30 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 376.843 kN.
-. Vr = 2987.289 kN.
-. Ratio = Vu / Vr = 0.126 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 418.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 418.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113220,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2636.64     -1407.32     -1233.15      -590.89      -515.59
           ---------------------------------------------------------------------------
            DL+LL+Others     2636.64     -1407.32     -1233.15      -590.89      -515.59
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1233.15 kN-m.
           -. End Moments (My2) =     1407.32 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1407.32 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1407.32 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      515.59 kN-m.
          -. End Moments (Mz2) =      590.89 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -590.89 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -590.89 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8605.353 kN.
          -. Mry        =      4566.684 kN-m.
          -. Mrz        =      1918.766 kN-m.
          -. Mr         =      4953.410 kN-m.
          -. Pu/Pr      =   0.306  --->  O.K !
          -. Muy/Mry    =   0.308  --->  O.K !
          -. Muz/Mrz    =   0.308  --->  O.K !
          -. Mu/Mr      =   0.308  --->  O.K !
          -. Ratio      =   0.308  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2636.64 kN.
          -. Vuz    =        348.33 kN.
          -. Muy    =      -1407.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        150.86 kN.
          -. Muz    =       -590.89 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75
```

( ). Compute shear strength of concrete.
-. Vuz = 348.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1284.21 kN.
-. phiVcz = phi * Vcz = 1155.79 kN.

-. Vuy = 150.86 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1242.00 kN.
-. phiVcy = phi * Vcy = 1117.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2147.12 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5864.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2147.12 kN.
-. phiVsz = phi*Vsz = 1932.41 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2125.03 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5906.49 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2125.03 kN.
-. phiVsy = phi*Vsy = 1912.53 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 379.598 kN.
-. Vr = 3030.330 kN.
-. Ratio = Vu / Vr = 0.125 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 421.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 421.78 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0013 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0013 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113221,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2653.31     -1233.15     -1062.45      -515.59      -442.51
           ------------------------------------------------------------------------------
            DL+LL+Others     2653.31     -1233.15     -1062.45      -515.59      -442.51
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1062.45 kN-m.
           -. End Moments (My2) =     1233.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1233.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1233.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      442.51 kN-m.
          -. End Moments (Mz2) =      515.59 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -515.59 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -515.59 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9639.136 kN.
          -. Mry        =      4482.407 kN-m.
          -. Mrz        =      1875.779 kN-m.
          -. Mr         =      4859.065 kN-m.
          -. Pu/Pr      =   0.275  --->  O.K !
          -. Muy/Mry    =   0.275  --->  O.K !
          -. Muz/Mrz    =   0.275  --->  O.K !
          -. Mu/Mr      =   0.275  --->  O.K !
          -. Ratio      =   0.275  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2653.31 kN.
          -. Vuz    =        341.40 kN.
          -. Muy    =      -1233.15 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.92

          -. Vuy    =        146.35 kN.
          -. Muz    =       -515.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.83
```

( ). Compute shear strength of concrete.
-. Vuz = 341.40 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1318.26 kN.
-. phiVcz = phi * Vcz = 1186.43 kN.

-. Vuy = 146.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1276.54 kN.
-. phiVcy = phi * Vcy = 1148.89 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2164.13 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5830.23 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2164.13 kN.
-. phiVsz = phi*Vsz = 1947.72 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2143.20 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5871.94 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2143.20 kN.
-. phiVsy = phi*Vsy = 1928.88 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 371.443 kN.
-. Vr = 3077.765 kN.
-. Ratio = Vu / Vr = 0.121 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 412.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 412.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113222,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2669.99     -1062.45      -899.16      -442.51      -373.18
           ------------------------------------------------------------------------------
            DL+LL+Others     2669.99     -1062.45      -899.16      -442.51      -373.18
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      899.16 kN-m.
           -. End Moments (My2) =     1062.45 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1062.45 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1062.45 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      373.18 kN-m.
          -. End Moments (Mz2) =      442.51 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -442.51 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -442.51 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     10960.543 kN.
          -. Mry        =      4376.718 kN-m.
          -. Mrz        =      1824.768 kN-m.
          -. Mr         =      4741.881 kN-m.
          -. Pu/Pr      =   0.244  --->  O.K !
          -. Muy/Mry    =   0.243  --->  O.K !
          -. Muz/Mrz    =   0.243  --->  O.K !
          -. Mu/Mr      =   0.244  --->  O.K !
          -. Ratio      =   0.244  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2669.99 kN.
          -. Vuz    =        326.61 kN.
          -. Muy    =      -1062.45 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =        138.78 kN.
          -. Muz    =       -442.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 326.61 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1354.78 kN.
-. phiVcz = phi * Vcz = 1219.30 kN.

-. Vuy = 138.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1313.70 kN.
-. phiVcy = phi * Vcy = 1182.33 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2181.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5793.70 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2181.62 kN.
-. phiVsz = phi*Vsz = 1963.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2161.89 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5834.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2161.89 kN.
-. phiVsy = phi*Vsy = 1945.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 354.872 kN.
-. Vr = 3128.035 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 394.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 394.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy
=3.6647e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy
=4.3597e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =4.3597e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113223,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2686.66      -899.16      -744.51      -373.18      -307.94
           ------------------------------------------------------------------------------
            DL+LL+Others     2686.66      -899.16      -744.51      -373.18      -307.94
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      744.51 kN-m.
           -. End Moments (My2) =      899.16 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -899.16 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -899.16 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      307.94 kN-m.
          -. End Moments (Mz2) =      373.18 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -373.18 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -373.18 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     12586.491 kN.
          -. Mry        =      4231.457 kN-m.
          -. Mrz        =      1758.296 kN-m.
          -. Mr         =      4582.230 kN-m.
          -. Pu/Pr      =   0.213  --->  O.K !
          -. Muy/Mry    =   0.212  --->  O.K !
          -. Muz/Mrz    =   0.212  --->  O.K !
          -. Mu/Mr      =   0.213  --->  O.K !
          -. Ratio      =   0.213  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2686.66 kN.
          -. Vuz    =        309.32 kN.
          -. Muy    =       -899.16 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.08

          -. Vuy    =        130.56 kN.
          -. Muz    =       -373.18 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.99
```

( ). Compute shear strength of concrete.
-. Vuz = 309.32 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1392.14 kN.
-. phiVcz = phi * Vcz = 1252.93 kN.

-. Vuy = 130.56 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1351.81 kN.
-. phiVcy = phi * Vcy = 1216.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2198.76 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5756.34 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2198.76 kN.
-. phiVsz = phi*Vsz = 1978.89 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2180.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5796.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2180.23 kN.
-. phiVsy = phi*Vsy = 1962.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 335.743 kN.
-. Vr = 3178.834 kN.
-. Ratio = Vu / Vr = 0.106 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 373.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 373.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113224,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2703.33      -744.51      -598.12      -307.94      -246.48
           ------------------------------------------------------------------------------
            DL+LL+Others     2703.33      -744.51      -598.12      -307.94      -246.48
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      598.12 kN-m.
           -. End Moments (My2) =      744.51 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -744.51 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -744.51 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      246.48 kN-m.
          -. End Moments (Mz2) =      307.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -307.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -307.94 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14530.821 kN.
          -. Mry        =      4022.479 kN-m.
          -. Mrz        =      1664.474 kN-m.
          -. Mr         =      4353.253 kN-m.
          -. Pu/Pr      =   0.186  --->  O.K !
          -. Muy/Mry    =   0.185  --->  O.K !
          -. Muz/Mrz    =   0.185  --->  O.K !
          -. Mu/Mr      =   0.186  --->  O.K !
          -. Ratio      =   0.186  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2703.33 kN.
          -. Vuz    =        292.79 kN.
          -. Muy    =       -744.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.41 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.16

          -. Vuy    =        123.00 kN.
          -. Muz    =       -307.94 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.08
```

( ). Compute shear strength of concrete.
-. Vuz = 292.79 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1429.37 kN.
-. phiVcz = phi * Vcz = 1286.43 kN.

-. Vuy = 123.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1389.89 kN.
-. phiVcy = phi * Vcy = 1250.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2215.13 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5719.12 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2215.13 kN.
-. phiVsz = phi*Vsz = 1993.62 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2197.75 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5758.60 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2197.75 kN.
-. phiVsy = phi*Vsy = 1977.97 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 317.577 kN.
-. Vr = 3228.873 kN.
-. Ratio = Vu / Vr = 0.098 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 352.86 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 352.86 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
===========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113225,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2720.00      -598.12      -460.64      -246.48      -189.01
           ---------------------------------------------------------------------------
            DL+LL+Others     2720.00      -598.12      -460.64      -246.48      -189.01
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      460.64 kN-m.
           -. End Moments (My2) =      598.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -598.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -598.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      189.01 kN-m.
          -. End Moments (Mz2) =      246.48 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -246.48 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -246.48 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     16821.227 kN.
          -. Mry        =      3713.683 kN-m.
          -. Mrz        =      1531.527 kN-m.
          -. Mr         =      4017.091 kN-m.
          -. Pu/Pr      =   0.162  --->  O.K !
          -. Muy/Mry    =   0.161  --->  O.K !
          -. Muz/Mrz    =   0.161  --->  O.K !
          -. Mu/Mr      =   0.162  --->  O.K !
          -. Ratio      =   0.162  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2720.00 kN.
          -. Vuz    =        274.98 kN.
          -. Muy    =       -598.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.25

          -. Vuy    =        115.03 kN.
          -. Muz    =       -246.48 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.42 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.16
```

( ). Compute shear strength of concrete.
-. Vuz = 274.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1466.83 kN.
-. phiVcz = phi * Vcz = 1320.15 kN.

-. Vuy = 115.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1428.31 kN.
-. phiVcy = phi * Vcy = 1285.48 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2230.93 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5681.66 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2230.93 kN.
-. phiVsz = phi*Vsz = 2007.83 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2214.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5720.17 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2214.67 kN.
-. phiVsy = phi*Vsy = 1993.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 298.069 kN.
-. Vr = 3278.689 kN.
-. Ratio = Vu / Vr = 0.091 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 331.19 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 331.19 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0017 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0017 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113226,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2736.67      -460.64      -332.24      -189.01      -135.53
           ------------------------------------------------------------------------------
            DL+LL+Others     2736.67      -460.64      -332.24      -189.01      -135.53
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      332.24 kN-m.
           -. End Moments (My2) =      460.64 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -460.64 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -460.64 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      135.53 kN-m.
          -. End Moments (Mz2) =      189.01 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -189.01 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -189.01 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     19349.026 kN.
          -. Mry        =      3281.609 kN-m.
          -. Mrz        =      1348.058 kN-m.
          -. Mr         =      3547.706 kN-m.
          -. Pu/Pr      =   0.141  --->  O.K !
          -. Muy/Mry    =   0.140  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.141  --->  O.K !
          -. Ratio      =   0.141  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2736.67 kN.
          -. Vuz    =        256.81 kN.
          -. Muy    =       -460.64 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.33

          -. Vuy    =        107.03 kN.
          -. Muz    =       -189.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 256.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1504.03 kN.
-. phiVcz = phi * Vcz = 1353.63 kN.

-. Vuy = 107.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1466.58 kN.
-. phiVcy = phi * Vcy = 1319.92 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2245.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5644.45 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2245.99 kN.
-. phiVsz = phi*Vsz = 2021.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2230.82 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5681.90 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2230.82 kN.
-. phiVsy = phi*Vsy = 2007.74 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 278.221 kN.
-. Vr = 3327.664 kN.
-. Ratio = Vu / Vr = 0.084 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 309.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 309.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113227,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3047.72      -228.65      -152.50      -200.35      -132.41
           ------------------------------------------------------------------------------
            DL+LL+Others     3047.72      -228.65      -152.50      -200.35      -132.41
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      152.50 kN-m.
           -. End Moments (My2) =      228.65 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -228.65 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -228.65 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      132.41 kN-m.
          -. End Moments (Mz2) =      200.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -200.35 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -200.35 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     23758.689 kN.
          -. Mry        =      1798.733 kN-m.
          -. Mrz        =      1571.481 kN-m.
          -. Mr         =      2388.512 kN-m.
          -. Pu/Pr      =   0.128  --->  O.K !
          -. Muy/Mry    =   0.127  --->  O.K !
          -. Muz/Mrz    =   0.127  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2753.34 kN.
          -. Vuz    =        221.68 kN.
          -. Muy    =       -332.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.42

          -. Vuy    =         91.80 kN.
          -. Muz    =       -135.53 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.34
```

( ). Compute shear strength of concrete.
-. Vuz = 221.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1544.69 kN.
-. phiVcz = phi * Vcz = 1390.22 kN.

-. Vuy = 91.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1508.53 kN.
-. phiVcy = phi * Vcy = 1357.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2261.78 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5603.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2261.78 kN.
-. phiVsz = phi*Vsz = 2035.60 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2247.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5639.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2247.77 kN.
-. phiVsy = phi*Vsy = 2022.99 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 239.932 kN.
-. Vr = 3380.663 kN.
-. Ratio = Vu / Vr = 0.071 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 266.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 266.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113228,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3081.04      -152.50       -93.36      -132.41       -80.25
           ------------------------------------------------------------------------------
            DL+LL+Others     3081.04      -152.50       -93.36      -132.41       -80.25
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       93.36 kN-m.
           -. End Moments (My2) =      152.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -93.36 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -93.36 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       80.25 kN-m.
          -. End Moments (Mz2) =      132.41 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -80.25 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -80.25 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       739.632 kN-m.
          -. Mrz        =       635.570 kN-m.
          -. Mr         =       975.194 kN-m.
          -. Pu/Pr      =   0.126  --->  O.K !
          -. Muy/Mry    =   0.126  --->  O.K !
          -. Muz/Mrz    =   0.126  --->  O.K !
          -. Mu/Mr      =   0.126  --->  O.K !
          -. Ratio      =   0.126  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2770.00 kN.
          -. Vuz    =        171.95 kN.
          -. Muy    =       -221.40 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.51

          -. Vuy    =         70.53 kN.
          -. Muz    =        -89.67 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.86 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.43
```

( ). Compute shear strength of concrete.
-. Vuz = 171.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1586.14 kN.
-. phiVcz = phi * Vcz = 1427.53 kN.

-. Vuy = 70.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1551.42 kN.
-. phiVcy = phi * Vcy = 1396.28 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2277.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5562.34 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2277.20 kN.
-. phiVsz = phi*Vsz = 2049.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2264.32 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5597.07 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2264.32 kN.
-. phiVsy = phi*Vsy = 2037.89 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 185.856 kN.
-. Vr = 3434.169 kN.
-. Ratio = Vu / Vr = 0.054 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 206.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 206.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113229,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3097.71       -93.36       -50.01       -80.25       -42.51
           ------------------------------------------------------------------------------
            DL+LL+Others     3097.71       -93.36       -50.01       -80.25       -42.51
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       50.01 kN-m.
           -. End Moments (My2) =       93.36 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -50.01 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -50.01 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       42.51 kN-m.
          -. End Moments (Mz2) =       80.25 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -42.51 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -42.51 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       394.143 kN-m.
          -. Mrz        =       334.741 kN-m.
          -. Mr         =       517.108 kN-m.
          -. Pu/Pr      =   0.127  --->  O.K !
          -. Muy/Mry    =   0.127  --->  O.K !
          -. Muz/Mrz    =   0.127  --->  O.K !
          -. Mu/Mr      =   0.127  --->  O.K !
          -. Ratio      =   0.127  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2786.66 kN.
          -. Vuz    =        125.91 kN.
          -. Muy    =       -135.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.59

          -. Vuy    =         51.12 kN.
          -. Muz    =        -54.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.71 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.51
```

( ). Compute shear strength of concrete.
-. Vuz = 125.91 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1621.31 kN.
-. phiVcz = phi * Vcz = 1459.18 kN.

-. Vuy = 51.12 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1587.91 kN.
-. phiVcy = phi * Vcy = 1429.12 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2289.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5527.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2289.77 kN.
-. phiVsz = phi*Vsz = 2060.79 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2277.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5560.57 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2277.84 kN.
-. phiVsy = phi*Vsy = 2050.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 135.890 kN.
-. Vr = 3479.176 kN.
-. Ratio = Vu / Vr = 0.039 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 150.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 150.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113230,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3114.37       -50.01       -21.02       -42.51       -17.63
           ------------------------------------------------------------------------------
            DL+LL+Others     3114.37       -50.01       -21.02       -42.51       -17.63
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       21.02 kN-m.
           -. End Moments (My2) =       50.01 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -21.02 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -21.02 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       17.63 kN-m.
          -. End Moments (Mz2) =       42.51 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -17.63 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -17.63 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       164.814 kN-m.
          -. Mrz        =       138.029 kN-m.
          -. Mr         =       214.979 kN-m.
          -. Pu/Pr      =   0.128  --->  O.K !
          -. Muy/Mry    =   0.128  --->  O.K !
          -. Muz/Mrz    =   0.128  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2819.98 kN.
          -. Vuz    =         84.09 kN.
          -. Muy    =        -30.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.65

          -. Vuy    =         33.76 kN.
          -. Muz    =        -12.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.60 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.58
```

( ). Compute shear strength of concrete.
-. Vuz = 84.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1647.48 kN.
-. phiVcz = phi * Vcz = 1482.74 kN.

-. Vuy = 33.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1615.14 kN.
-. phiVcy = phi * Vcy = 1453.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2298.85 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5501.00 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2298.85 kN.
-. phiVsz = phi*Vsz = 2068.96 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2287.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5533.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2287.60 kN.
-. phiVsy = phi*Vsy = 2058.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 90.620 kN.
-. Vr = 3512.467 kN.
-. Ratio = Vu / Vr = 0.026 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 100.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 100.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113231,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3131.03       -21.02        -4.87       -17.63        -4.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3131.03       -21.02        -4.87       -17.63        -4.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.87 kN-m.
           -. End Moments (My2) =       21.02 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.00 kN-m.
          -. End Moments (Mz2) =       17.63 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        37.982 kN-m.
          -. Mrz        =        31.165 kN-m.
          -. Mr         =        49.131 kN-m.
          -. Pu/Pr      =   0.128  --->  O.K !
          -. Muy/Mry    =   0.128  --->  O.K !
          -. Muz/Mrz    =   0.128  --->  O.K !
          -. Mu/Mr      =   0.128  --->  O.K !
          -. Ratio      =   0.128  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2836.64 kN.
          -. Vuz    =         46.78 kN.
          -. Muy    =         -7.03 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.41 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.69

          -. Vuy    =         18.55 kN.
          -. Muz    =         -2.75 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.53 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.62
```

( ). Compute shear strength of concrete.
-. Vuz = 46.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1665.66 kN.
-. phiVcz = phi * Vcz = 1499.09 kN.

-. Vuy = 18.55 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1634.08 kN.
-. phiVcy = phi * Vcy = 1470.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2305.01 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5482.83 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2305.01 kN.
-. phiVsz = phi*Vsz = 2074.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2294.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5514.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2294.23 kN.
-. phiVsy = phi*Vsy = 2064.81 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 50.326 kN.
-. Vr = 3535.479 kN.
-. Ratio = Vu / Vr = 0.014 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 55.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 55.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =113232,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3147.69        -4.87         0.00        -4.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3147.69        -4.87         0.00        -4.00         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        4.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        4.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.129  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.129  --->  O.K !
          -. Ratio      =   0.129  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2853.30 kN.
          -. Vuz    =         14.07 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.46 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.65

          -. Vuy    =          5.49 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.65
```

( ). Compute shear strength of concrete.
-. Vuz = 14.07 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1650.72 kN.
-. phiVcz = phi * Vcz = 1485.65 kN.

-. Vuy = 5.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1650.72 kN.
-. phiVcy = phi * Vcy = 1485.65 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2299.95 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5497.77 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2299.95 kN.
-. phiVsz = phi*Vsz = 2069.96 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2299.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5497.77 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2299.95 kN.
-. phiVsy = phi*Vsy = 2069.96 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 15.103 kN.
-. Vr = 3555.604 kN.
-. Ratio = Vu / Vr = 0.004 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 16.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 16.78 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114102,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2890.89      -149.38      -324.96      -435.18      -752.14
           ------------------------------------------------------------------------------
            DL+LL+Others     2890.89      -149.38      -324.96      -435.18      -752.14
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      149.38 kN-m.
           -. End Moments (My2) =      324.96 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -324.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -324.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      435.18 kN-m.
          -. End Moments (Mz2) =      752.14 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -752.14 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -752.14 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15036.950 kN.
          -. Mry        =      1698.387 kN-m.
          -. Mrz        =      3934.410 kN-m.
          -. Mr         =      4285.335 kN-m.
          -. Pu/Pr      =   0.192  --->  O.K !
          -. Muy/Mry    =   0.191  --->  O.K !
          -. Muz/Mrz    =   0.191  --->  O.K !
          -. Mu/Mr      =   0.192  --->  O.K !
          -. Ratio      =   0.192  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2511.75 kN.
          -. Vuz    =        867.50 kN.
          -. Muy    =       -480.04 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90

          -. Vuy    =        536.33 kN.
          -. Muz    =       -598.20 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.31 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.81
```

( ). Compute shear strength of concrete.
-. Vuz = 867.50 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1310.24 kN.
-. phiVcz = phi * Vcz = 1179.22 kN.

-. Vuy = 536.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1268.41 kN.
-. phiVcy = phi * Vcy = 1141.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2160.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5838.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2160.19 kN.
-. phiVsz = phi*Vsz = 1944.17 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2138.99 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5880.08 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2138.99 kN.
-. phiVsy = phi*Vsy = 1925.09 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1019.909 kN.
-. Vr = 3066.655 kN.
-. Ratio = Vu / Vr = 0.333 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1133.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1133.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114103,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2907.63      -324.96      -542.77      -752.14     -1046.20
           ------------------------------------------------------------------------------
            DL+LL+Others     2907.63      -324.96      -542.77      -752.14     -1046.20
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      324.96 kN-m.
           -. End Moments (My2) =      542.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -542.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -542.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      752.14 kN-m.
          -. End Moments (Mz2) =     1046.20 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1046.20 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1046.20 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11488.083 kN.
          -. Mry        =      2164.642 kN-m.
          -. Mrz        =      4163.662 kN-m.
          -. Mr         =      4692.734 kN-m.
          -. Pu/Pr      =   0.253  --->  O.K !
          -. Muy/Mry    =   0.251  --->  O.K !
          -. Muz/Mrz    =   0.251  --->  O.K !
          -. Mu/Mr      =   0.253  --->  O.K !
          -. Ratio      =   0.253  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2528.47 kN.
          -. Vuz    =        772.34 kN.
          -. Muy    =       -830.33 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.84

          -. Vuy    =        474.84 kN.
          -. Muz    =       -767.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74
```

( ). Compute shear strength of concrete.
-. Vuz = 772.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1281.93 kN.
-. phiVcz = phi * Vcz = 1153.74 kN.

-. Vuy = 474.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1239.70 kN.
-. phiVcy = phi * Vcy = 1115.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2145.96 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5866.55 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2145.96 kN.
-. phiVsz = phi*Vsz = 1931.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2123.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5908.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2123.79 kN.
-. phiVsy = phi*Vsy = 1911.42 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 906.632 kN.
-. Vr = 3027.141 kN.
-. Ratio = Vu / Vr = 0.300 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1007.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1007.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114104,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -315.99       525.68       730.52       990.81      1269.32
           ---------------------------------------------------------------------------
           DL+LL+Others     -315.99       525.68       730.52       990.81      1269.32
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1016.818 kN.
          -. Mry        =      2332.865 kN-m.
          -. Mrz        =      4055.767 kN-m.
          -. Mr         =      4678.836 kN-m.
          -. Pu/Pr      =   0.311  --->  O.K !
          -. Muy/Mry    =   0.313  --->  O.K !
          -. Muz/Mrz    =   0.313  --->  O.K !
          -. Mu/Mr      =   0.313  --->  O.K !
          -. Ratio      =   0.313  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2545.18 kN.
          -. Vuz    =        677.77 kN.
          -. Muy    =      -1137.79 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75
```

```
          -. Vuy    =       414.04 kN.
          -. Muz    =      -925.38 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65

     ( ). Compute shear strength of concrete.
          -. Vuz       =     677.77 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1240.44 kN.
          -. phiVcz    = phi * Vcz =     1116.40 kN.

          -. Vuy       =     414.04 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1197.72 kN.
          -. phiVcy    = phi * Vcy =     1077.95 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2124.20 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5908.05 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2124.20 kN.
          -. phiVsz   = phi*Vsz =     1911.78 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2100.57 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5950.76 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2100.57 kN.
          -. phiVsy   = phi*Vsy =     1890.52 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     794.224 kN.
          -. Vr       =    2968.467 kN.
          -. Ratio    = Vu / Vr = 0.268  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 882.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 882.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114105,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -304.07       730.52       908.82      1269.32      1507.53
           ---------------------------------------------------------------------------
           DL+LL+Others     -304.07       730.52       908.82      1269.32      1507.53
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -810.545 kN.
          -. Mry        =      2436.212 kN-m.
          -. Mrz        =      4049.209 kN-m.
          -. Mr         =      4725.592 kN-m.
          -. Pu/Pr      =   0.375  --->  O.K !
          -. Muy/Mry    =   0.373  --->  O.K !
          -. Muz/Mrz    =   0.372  --->  O.K !
          -. Mu/Mr      =   0.375  --->  O.K !
          -. Ratio      =   0.375  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2561.89 kN.
          -. Vuz    =        584.77 kN.
          -. Muy    =      -1403.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.67
```

```
          -. Vuy    =       354.56 kN.
          -. Muz    =     -1062.08 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.58

     ( ). Compute shear strength of concrete.
          -. Vuz       =     584.77 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1207.83 kN.
          -. phiVcz    = phi * Vcz =     1087.04 kN.

          -. Vuy       =     354.56 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1164.82 kN.
          -. phiVcy    = phi * Vcy =     1048.34 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2106.28 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5940.66 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2106.28 kN.
          -. phiVsz   = phi*Vsz =     1895.65 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2081.48 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5983.67 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2081.48 kN.
          -. phiVsy   = phi*Vsy =     1873.33 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     683.868 kN.
          -. Vr       =    2921.669 kN.
          -. Ratio    = Vu / Vr = 0.234  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 759.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 759.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0028 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0028 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114106,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -292.16       908.82      1059.68      1507.53      1705.79
           ---------------------------------------------------------------------------
           DL+LL+Others     -292.16       908.82      1059.68      1507.53      1705.79
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -686.733 kN.
          -. Mry        =      2508.115 kN-m.
          -. Mrz        =      4040.002 kN-m.
          -. Mr         =      4755.235 kN-m.
          -. Pu/Pr      =   0.425  --->  O.K !
          -. Muy/Mry    =   0.423  --->  O.K !
          -. Muz/Mrz    =   0.422  --->  O.K !
          -. Mu/Mr      =   0.425  --->  O.K !
          -. Ratio      =   0.425  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2578.59 kN.
          -. Vuz    =        494.41 kN.
          -. Muy    =      -1626.85 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62
```

```
          -. Vuy    =       297.14 kN.
          -. Muz    =     -1175.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.52

     ( ). Compute shear strength of concrete.
          -. Vuz       =     494.41 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1183.26 kN.
          -. phiVcz    = phi * Vcz =     1064.93 kN.

          -. Vuy       =     297.14 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1140.09 kN.
          -. phiVcy    = phi * Vcy =     1026.08 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2092.28 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5965.23 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2092.28 kN.
          -. phiVsz   = phi*Vsz =     1883.05 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2066.57 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6008.40 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2066.57 kN.
          -. phiVsy   = phi*Vsy =     1859.91 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     576.828 kN.
          -. Vr       =    2885.991 kN.
          -. Ratio    = Vu / Vr = 0.200  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 640.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 640.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114107,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -280.24      1059.68      1183.76      1705.79      1868.10
           ---------------------------------------------------------------------------
           DL+LL+Others     -280.24      1059.68      1183.76      1705.79      1868.10
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -610.491 kN.
          -. Mry        =      2555.054 kN-m.
          -. Mrz        =      4032.299 kN-m.
          -. Mr         =      4773.651 kN-m.
          -. Pu/Pr      =   0.459  --->  O.K !
          -. Muy/Mry    =   0.463  --->  O.K !
          -. Muz/Mrz    =   0.463  --->  O.K !
          -. Mu/Mr      =   0.463  --->  O.K !
          -. Ratio      =   0.463  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2595.30 kN.
          -. Vuz    =        407.68 kN.
          -. Muy    =      -1809.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.02 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.58
```

```
          -. Vuy    =       242.46 kN.
          -. Muz    =     -1268.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48

     ( ). Compute shear strength of concrete.
          -. Vuz       =     407.68 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1165.45 kN.
          -. phiVcz    = phi * Vcz =     1048.90 kN.

          -. Vuy       =     242.46 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1122.19 kN.
          -. phiVcy    = phi * Vcy =     1009.97 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2081.85 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5983.04 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2081.85 kN.
          -. phiVsz   = phi*Vsz =     1873.66 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2055.47 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6026.30 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2055.47 kN.
          -. phiVsy   = phi*Vsy =     1849.92 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     474.329 kN.
          -. Vr       =    2859.890 kN.
          -. Ratio    = Vu / Vr = 0.166  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 527.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 527.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114108,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -268.32      1183.76      1292.35      1868.10      1994.26
           ---------------------------------------------------------------------------
           DL+LL+Others     -268.32      1183.76      1292.35      1868.10      1994.26
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -542.793 kN.
          -. Mry        =      2605.852 kN-m.
          -. Mrz        =      4019.352 kN-m.
          -. Mr         =      4790.162 kN-m.
          -. Pu/Pr      =   0.494  --->  O.K !
          -. Muy/Mry    =   0.496  --->  O.K !
          -. Muz/Mrz    =   0.496  --->  O.K !
          -. Mu/Mr      =   0.496  --->  O.K !
          -. Ratio      =   0.496  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2612.00 kN.
          -. Vuz    =        325.61 kN.
          -. Muy    =      -1964.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.11 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.55
```

```
          -. Vuy    =       191.31 kN.
          -. Muz    =     -1340.23 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.46

     ( ). Compute shear strength of concrete.
          -. Vuz       =     325.61 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1152.44 kN.
          -. phiVcz    = phi * Vcz =     1037.20 kN.

          -. Vuy       =     191.31 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1109.13 kN.
          -. phiVcy    = phi * Vcy =      998.22 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2074.07 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5996.05 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2074.07 kN.
          -. phiVsz   = phi*Vsz =     1866.67 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2047.19 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6039.36 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2047.19 kN.
          -. phiVsy   = phi*Vsy =     1842.47 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     377.654 kN.
          -. Vr       =    2840.692 kN.
          -. Ratio    = Vu / Vr = 0.133  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 419.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 419.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114109,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -256.39      1292.35      1376.60      1994.26      2087.71
           ---------------------------------------------------------------------------
           DL+LL+Others     -256.39      1292.35      1376.60      1994.26      2087.71
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -490.837 kN.
          -. Mry        =      2645.244 kN-m.
          -. Mrz        =      4008.889 kN-m.
          -. Mr         =      4802.968 kN-m.
          -. Pu/Pr      =   0.522  --->  O.K !
          -. Muy/Mry    =   0.520  --->  O.K !
          -. Muz/Mrz    =   0.521  --->  O.K !
          -. Mu/Mr      =   0.522  --->  O.K !
          -. Ratio      =   0.522  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2628.70 kN.
          -. Vuz    =        249.16 kN.
          -. Muy    =      -2082.33 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.18 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.53
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```
          -. Vuy    =       144.64 kN.
          -. Muz    =     -1391.94 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.52 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.44

     ( ). Compute shear strength of concrete.
          -. Vuz       =     249.16 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1144.51 kN.
          -. phiVcz    = phi * Vcz =     1030.06 kN.

          -. Vuy       =     144.64 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1101.18 kN.
          -. phiVcy    = phi * Vcy =      991.06 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2069.27 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6003.97 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2069.27 kN.
          -. phiVsz   = phi*Vsz =     1862.34 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2042.09 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6047.31 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2042.09 kN.
          -. phiVsy   = phi*Vsy =     1837.88 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     288.097 kN.
          -. Vr       =    2828.938 kN.
          -. Ratio    = Vu / Vr = 0.102  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 320.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 320.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114110,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -244.47      1376.60      1430.79      2087.71      2142.72
           ---------------------------------------------------------------------------
           DL+LL+Others     -244.47      1376.60      1430.79      2087.71      2142.72
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -454.139 kN.
          -. Mry        =      2673.761 kN-m.
          -. Mrz        =      4000.901 kN-m.
          -. Mr         =      4812.090 kN-m.
          -. Pu/Pr      =   0.538  --->  O.K !
          -. Muy/Mry    =   0.535  --->  O.K !
          -. Muz/Mrz    =   0.536  --->  O.K !
          -. Mu/Mr      =   0.538  --->  O.K !
          -. Ratio      =   0.538  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2645.40 kN.
          -. Vuz    =        157.56 kN.
          -. Muy    =      -2156.02 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.54
```

```
          -. Vuy    =         91.42 kN.
          -. Muz    =      -1420.68 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.52 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.44

     ( ). Compute shear strength of concrete.
          -. Vuz       =      157.56 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1145.49 kN.
          -. phiVcz    = phi * Vcz =     1030.94 kN.

          -. Vuy       =       91.42 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1102.16 kN.
          -. phiVcy    = phi * Vcy =      991.94 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2069.87 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6003.00 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2069.87 kN.
          -. phiVsz   = phi*Vsz =     1862.88 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2042.72 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6046.33 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2042.72 kN.
          -. phiVsy   = phi*Vsy =     1838.45 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     182.162 kN.
          -. Vr       =    2830.389 kN.
          -. Ratio    = Vu / Vr = 0.064  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 202.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 202.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0041 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114111,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -244.53      1430.79      1445.31      2142.72      2143.04
           ---------------------------------------------------------------------------
           DL+LL+Others     -244.53      1430.79      1445.31      2142.72      2143.04
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -454.139 kN.
          -. Mry        =      2673.761 kN-m.
          -. Mrz        =      4000.901 kN-m.
          -. Mr         =      4812.090 kN-m.
          -. Pu/Pr      =   0.538  --->  O.K !
          -. Muy/Mry    =   0.535  --->  O.K !
          -. Muz/Mrz    =   0.536  --->  O.K !
          -. Mu/Mr      =   0.538  --->  O.K !
          -. Ratio      =   0.538  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2662.10 kN.
          -. Vuz    =         38.23 kN.
          -. Muy    =      -2171.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56
```

```
          -. Vuy    =         47.58 kN.
          -. Muz    =      -1414.76 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.41 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.47

     ( ). Compute shear strength of concrete.
          -. Vuz       =       38.23 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1157.85 kN.
          -. phiVcz    = phi * Vcz =     1042.07 kN.

          -. Vuy       =       47.58 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1114.56 kN.
          -. phiVcy    = phi * Vcy =     1003.11 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2077.33 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5990.63 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2077.33 kN.
          -. phiVsz   = phi*Vsz =     1869.59 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2050.65 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6033.92 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2050.65 kN.
          -. phiVsy   = phi*Vsy =     1845.59 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =      61.031 kN.
          -. Vr       =    2848.697 kN.
          -. Ratio    = Vu / Vr = 0.021  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 67.81 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 67.81 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114112,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -232.59      1445.31      1424.81      2143.04      2095.53
           ---------------------------------------------------------------------------
           DL+LL+Others     -232.59      1445.31      1424.81      2143.04      2095.53
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -432.510 kN.
          -. Mry        =      2695.340 kN-m.
          -. Mrz        =      3992.997 kN-m.
          -. Mr         =      4817.560 kN-m.
          -. Pu/Pr      =   0.538  --->  O.K !
          -. Muy/Mry    =   0.536  --->  O.K !
          -. Muz/Mrz    =   0.537  --->  O.K !
          -. Mu/Mr      =   0.538  --->  O.K !
          -. Ratio      =   0.538  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3041.51 kN.
          -. Vuz    =         54.20 kN.
          -. Muy    =      -1404.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.52
```

```
          -. Vuy    =       113.86 kN.
          -. Muz    =     -2096.05 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.59 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.42

     ( ). Compute shear strength of concrete.
          -. Vuz       =      54.20 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1136.69 kN.
          -. phiVcz    = phi * Vcz =     1023.02 kN.

          -. Vuy       =     113.86 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1093.34 kN.
          -. phiVcy    = phi * Vcy =      984.00 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2064.48 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6011.79 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2064.48 kN.
          -. phiVsz   = phi*Vsz =     1858.03 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2036.99 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6055.15 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2036.99 kN.
          -. phiVsy   = phi*Vsy =     1833.29 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     126.103 kN.
          -. Vr       =    2817.298 kN.
          -. Ratio    = Vu / Vr = 0.045  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 140.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 140.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114113,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -220.66      1424.81      1374.60      2095.53      2007.90
           ---------------------------------------------------------------------------
           DL+LL+Others     -220.66      1424.81      1374.60      2095.53      2007.90
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -418.361 kN.
          -. Mry        =      2712.564 kN-m.
          -. Mrz        =      3985.731 kN-m.
          -. Mr         =      4821.209 kN-m.
          -. Pu/Pr      =   0.527  --->  O.K !
          -. Muy/Mry    =   0.525  --->  O.K !
          -. Muz/Mrz    =   0.526  --->  O.K !
          -. Mu/Mr      =   0.527  --->  O.K !
          -. Ratio      =   0.527  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3058.22 kN.
          -. Vuz    =        106.19 kN.
          -. Muy    =      -1382.37 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.27 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51
```

```
          -. Vuy    =       185.37 kN.
          -. Muz    =     -2044.33 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41

     ( ). Compute shear strength of concrete.
          -. Vuz       =     106.19 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1132.91 kN.
          -. phiVcz    = phi * Vcz =     1019.62 kN.

          -. Vuy       =     185.37 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1089.55 kN.
          -. phiVcy    = phi * Vcy =      980.59 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2062.15 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6015.57 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2062.15 kN.
          -. phiVsz   = phi*Vsz =     1855.93 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2034.51 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6058.94 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2034.51 kN.
          -. phiVsy   = phi*Vsy =     1831.06 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     213.633 kN.
          -. Vr       =    2811.655 kN.
          -. Ratio    = Vu / Vr = 0.076  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 237.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 237.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0032 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114114,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -208.72      1374.60      1300.30      2007.90      1888.33
           ---------------------------------------------------------------------------
           DL+LL+Others     -208.72      1374.60      1300.30      2007.90      1888.33
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -411.658 kN.
          -. Mry        =      2726.378 kN-m.
          -. Mrz        =      3978.520 kN-m.
          -. Mr         =      4823.045 kN-m.
          -. Pu/Pr      =   0.507  --->  O.K !
          -. Muy/Mry    =   0.504  --->  O.K !
          -. Muz/Mrz    =   0.505  --->  O.K !
          -. Mu/Mr      =   0.507  --->  O.K !
          -. Ratio      =   0.507  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3074.93 kN.
          -. Vuz    =        148.50 kN.
          -. Muy    =      -1331.98 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.52
```

-. Vuy = 242.39 kN.
-. Muz = -1954.59 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.58 Deg. [Clause 5.8.3.4.2]
-. betay = 2.42

( ). Compute shear strength of concrete.
-. Vuz = 148.50 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1137.60 kN.
-. phiVcz = phi * Vcz = 1023.84 kN.

-. Vuy = 242.39 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1094.25 kN.
-. phiVcy = phi * Vcy = 984.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2065.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6010.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2065.04 kN.
-. phiVsz = phi*Vsz = 1858.54 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2037.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6054.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2037.59 kN.
-. phiVsy = phi*Vsy = 1833.83 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 284.262 kN.
-. Vr = 2818.655 kN.
-. Ratio = Vu / Vr = 0.101 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 315.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 315.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114115,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -196.77      1300.30      1207.71      1888.33      1745.13
           ---------------------------------------------------------------------------
           DL+LL+Others     -196.77      1300.30      1207.71      1888.33      1745.13
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -412.386 kN.
          -. Mry        =      2737.351 kN-m.
          -. Mrz        =      3971.013 kN-m.
          -. Mr         =      4823.073 kN-m.
          -. Pu/Pr      =   0.477  --->  O.K !
          -. Muy/Mry    =   0.475  --->  O.K !
          -. Muz/Mrz    =   0.476  --->  O.K !
          -. Mu/Mr      =   0.477  --->  O.K !
          -. Ratio      =   0.477  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2712.21 kN.
          -. Vuz    =        281.89 kN.
          -. Muy    =      -1941.34 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.57
```

```
          -. Vuy    =       193.53 kN.
          -. Muz    =     -1235.65 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48

     ( ). Compute shear strength of concrete.
          -. Vuz       =     281.89 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1161.57 kN.
          -. phiVcz    = phi * Vcz =     1045.41 kN.

          -. Vuy       =     193.53 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1118.29 kN.
          -. phiVcy    = phi * Vcy =     1006.46 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2079.54 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5986.92 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2079.54 kN.
          -. phiVsz   = phi*Vsz =     1871.59 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2053.01 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6030.19 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2053.01 kN.
          -. phiVsy   = phi*Vsy =     1847.71 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     341.929 kN.
          -. Vr       =    2854.173 kN.
          -. Ratio    = Vu / Vr = 0.120  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 379.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 379.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114116,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -184.83      1207.71      1102.91      1745.13      1586.91
           ---------------------------------------------------------------------------
           DL+LL+Others     -184.83      1207.71      1102.91      1745.13      1586.91
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -420.539 kN.
          -. Mry        =      2745.794 kN-m.
          -. Mrz        =      3963.015 kN-m.
          -. Mr         =      4821.294 kN-m.
          -. Pu/Pr      =   0.440  --->  O.K !
          -. Muy/Mry    =   0.440  --->  O.K !
          -. Muz/Mrz    =   0.440  --->  O.K !
          -. Mu/Mr      =   0.440  --->  O.K !
          -. Ratio      =   0.440  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2728.90 kN.
          -. Vuz    =        316.64 kN.
          -. Muy    =      -1800.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.91 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.61
```

```
          -. Vuy    =       210.66 kN.
          -. Muz    =     -1139.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.52

     ( ). Compute shear strength of concrete.
          -. Vuz       =     316.64 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1180.49 kN.
          -. phiVcz    = phi * Vcz =     1062.44 kN.

          -. Vuy       =     210.66 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1137.31 kN.
          -. phiVcy    = phi * Vcy =     1023.57 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2090.67 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5968.00 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2090.67 kN.
          -. phiVsz   = phi*Vsz =     1881.61 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2064.86 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6011.18 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2064.86 kN.
          -. phiVsy   = phi*Vsy =     1858.37 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     380.312 kN.
          -. Vr       =    2881.947 kN.
          -. Ratio    = Vu / Vr = 0.132  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 422.57 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 422.57 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114117,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -172.88      1102.91       991.86      1586.91      1421.90
           ---------------------------------------------------------------------------
           DL+LL+Others     -172.88      1102.91       991.86      1586.91      1421.90
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -428.632 kN.
          -. Mry        =      2752.860 kN-m.
          -. Mrz        =      3955.939 kN-m.
          -. Mr         =      4819.511 kN-m.
          -. Pu/Pr      =   0.403  --->  O.K !
          -. Muy/Mry    =   0.401  --->  O.K !
          -. Muz/Mrz    =   0.401  --->  O.K !
          -. Mu/Mr      =   0.403  --->  O.K !
          -. Ratio      =   0.403  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2745.58 kN.
          -. Vuz    =        333.90 kN.
          -. Muy    =      -1642.11 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.73 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.67
```

```
          -. Vuy    =       218.14 kN.
          -. Muz    =     -1034.46 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.57

     ( ). Compute shear strength of concrete.
          -. Vuz       =      333.90 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1205.67 kN.
          -. phiVcz    = phi * Vcz =     1085.10 kN.

          -. Vuy       =      218.14 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1162.65 kN.
          -. phiVcy    = phi * Vcy =     1046.38 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2105.07 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5942.82 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2105.07 kN.
          -. phiVsz   = phi*Vsz =     1894.56 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2080.19 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5985.84 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2080.19 kN.
          -. phiVsy   = phi*Vsy =     1872.17 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     398.838 kN.
          -. Vr       =    2918.553 kN.
          -. Ratio    = Vu / Vr = 0.137  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 443.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 443.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0024 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114118,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -160.93       991.86       878.93      1421.90      1256.18
           ---------------------------------------------------------------------------
           DL+LL+Others     -160.93       991.86       878.93      1421.90      1256.18
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -444.164 kN.
          -. Mry        =      2757.850 kN-m.
          -. Mrz        =      3948.079 kN-m.
          -. Mr         =      4815.918 kN-m.
          -. Pu/Pr      =   0.362  --->  O.K !
          -. Muy/Mry    =   0.360  --->  O.K !
          -. Muz/Mrz    =   0.360  --->  O.K !
          -. Mu/Mr      =   0.362  --->  O.K !
          -. Ratio      =   0.362  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2762.27 kN.
          -. Vuz    =        338.23 kN.
          -. Muy    =      -1475.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73
```

```
          -. Vuy    =       217.87 kN.
          -. Muz    =      -925.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64

     ( ). Compute shear strength of concrete.
          -. Vuz       =      338.23 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1235.55 kN.
          -. phiVcz    = phi * Vcz =     1112.00 kN.

          -. Vuy       =      217.87 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1192.79 kN.
          -. phiVcy    = phi * Vcy =     1073.51 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2121.56 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5912.93 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2121.56 kN.
          -. phiVsz   = phi*Vsz =     1909.40 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2097.76 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5955.70 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2097.76 kN.
          -. phiVsy   = phi*Vsy =     1887.99 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     402.332 kN.
          -. Vr       =    2961.495 kN.
          -. Ratio    = Vu / Vr = 0.136  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 447.04 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 447.04 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114119,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -148.97       878.93       767.70      1256.18      1094.66
           ---------------------------------------------------------------------------
           DL+LL+Others     -148.97       878.93       767.70      1256.18      1094.66
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -467.140 kN.
          -. Mry        =      2760.720 kN-m.
          -. Mrz        =      3939.466 kN-m.
          -. Mr         =      4810.506 kN-m.
          -. Pu/Pr      =   0.319  --->  O.K !
          -. Muy/Mry    =   0.318  --->  O.K !
          -. Muz/Mrz    =   0.319  --->  O.K !
          -. Mu/Mr      =   0.319  --->  O.K !
          -. Ratio      =   0.319  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2778.95 kN.
          -. Vuz    =        332.12 kN.
          -. Muy    =      -1306.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81
```

```
          -. Vuy    =        211.40 kN.
          -. Muz    =       -816.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.72

     ( ). Compute shear strength of concrete.
          -. Vuz       =      332.12 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1269.05 kN.
          -. phiVcz    = phi * Vcz =     1142.15 kN.

          -. Vuy       =      211.40 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1226.65 kN.
          -. phiVcy    = phi * Vcy =     1103.99 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2139.32 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5879.44 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2139.32 kN.
          -. phiVsz   = phi*Vsz =     1925.39 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2116.71 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5921.84 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2116.71 kN.
          -. phiVsy   = phi*Vsy =     1905.04 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     393.689 kN.
          -. Vr       =    3009.024 kN.
          -. Ratio    = Vu / Vr = 0.131  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 437.43 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 437.43 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114120,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2795.63     -1139.99      -978.67      -710.97      -609.02
           ------------------------------------------------------------------------------
            DL+LL+Others     2795.63     -1139.99      -978.67      -710.97      -609.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      978.67 kN-m.
           -. End Moments (My2) =     1139.99 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1139.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1139.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      609.02 kN-m.
          -. End Moments (Mz2) =      710.97 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -710.97 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -710.97 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9994.178 kN.
          -. Mry        =      4098.909 kN-m.
          -. Mrz        =      2562.766 kN-m.
          -. Mr         =      4834.131 kN-m.
          -. Pu/Pr      =   0.280  --->  O.K !
          -. Muy/Mry    =   0.278  --->  O.K !
          -. Muz/Mrz    =   0.277  --->  O.K !
          -. Mu/Mr      =   0.280  --->  O.K !
          -. Ratio      =   0.280  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2795.63 kN.
          -. Vuz    =        322.65 kN.
          -. Muy    =      -1139.99 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89

          -. Vuy    =        203.93 kN.
          -. Muz    =       -710.97 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.79
```

( ). Compute shear strength of concrete.
-. Vuz = 322.65 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1304.16 kN.
-. phiVcz = phi * Vcz = 1173.75 kN.

-. Vuy = 203.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1262.24 kN.
-. phiVcy = phi * Vcy = 1136.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2157.17 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5844.32 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2157.17 kN.
-. phiVsz = phi*Vsz = 1941.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2135.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5886.25 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2135.77 kN.
-. phiVsy = phi*Vsy = 1922.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 381.691 kN.
-. Vr = 3058.203 kN.
-. Ratio = Vu / Vr = 0.125 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 424.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 424.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114121,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2812.30      -978.67      -817.30      -609.02      -507.03
           ------------------------------------------------------------------------------
            DL+LL+Others     2812.30      -978.67      -817.30      -609.02      -507.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      817.30 kN-m.
           -. End Moments (My2) =      978.67 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -978.67 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -978.67 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      507.03 kN-m.
          -. End Moments (Mz2) =      609.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -609.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -609.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     11490.992 kN.
           -. Mry        =      3989.279 kN-m.
           -. Mrz        =      2473.856 kN-m.
           -. Mr         =      4694.071 kN-m.
           -. Pu/Pr      =   0.245  --->  O.K !
           -. Muy/Mry    =   0.245  --->  O.K !
           -. Muz/Mrz    =   0.246  --->  O.K !
           -. Mu/Mr      =   0.246  --->  O.K !
           -. Ratio      =   0.246  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2812.30 kN.
           -. Vuz    =        322.80 kN.
           -. Muy    =       -978.67 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.90 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.96

           -. Vuy    =        204.03 kN.
           -. Muz    =       -609.02 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.14 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.87
```

( ). Compute shear strength of concrete.
-. Vuz = 322.80 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1338.13 kN.
-. phiVcz = phi * Vcz = 1204.32 kN.

-. Vuy = 204.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1296.75 kN.
-. phiVcy = phi * Vcy = 1167.07 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2173.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5810.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2173.74 kN.
-. phiVsz = phi*Vsz = 1956.37 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2153.47 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5851.74 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2153.47 kN.
-. phiVsy = phi*Vsy = 1938.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 381.870 kN.
-. Vr = 3105.195 kN.
-. Ratio = Vu / Vr = 0.123 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 424.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 424.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0001 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114122,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3208.48      -531.34      -427.71      -754.26      -604.43
           ------------------------------------------------------------------------------
            DL+LL+Others     3208.48      -531.34      -427.71      -754.26      -604.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      427.71 kN-m.
           -. End Moments (My2) =      531.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -531.34 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -531.34 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      604.43 kN-m.
          -. End Moments (Mz2) =      754.26 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -754.26 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -754.26 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14955.945 kN.
          -. Mry        =      2477.929 kN-m.
          -. Mrz        =      3508.661 kN-m.
          -. Mr         =      4295.444 kN-m.
          -. Pu/Pr      =   0.215  --->  O.K !
          -. Muy/Mry    =   0.214  --->  O.K !
          -. Muz/Mrz    =   0.215  --->  O.K !
          -. Mu/Mr      =   0.215  --->  O.K !
          -. Ratio      =   0.215  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2828.98 kN.
          -. Vuz    =        319.47 kN.
          -. Muy    =       -817.30 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        201.70 kN.
          -. Muz    =       -507.03 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 319.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1374.66 kN.
-. phiVcz = phi * Vcz = 1237.20 kN.

-. Vuy = 201.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1333.97 kN.
-. phiVcy = phi * Vcy = 1200.57 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2190.83 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5773.82 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2190.83 kN.
-. phiVsz = phi*Vsz = 1971.75 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2171.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5814.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2171.74 kN.
-. phiVsy = phi*Vsy = 1954.57 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 377.813 kN.
-. Vr = 3155.139 kN.
-. Ratio = Vu / Vr = 0.120 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 419.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 419.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114123,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3225.17      -427.71      -330.13      -604.43      -464.03
           ------------------------------------------------------------------------------
            DL+LL+Others     3225.17      -427.71      -330.13      -604.43      -464.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      330.13 kN-m.
           -. End Moments (My2) =      427.71 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -427.71 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -427.71 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      464.03 kN-m.
          -. End Moments (Mz2) =      604.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -604.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -604.43 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17159.606 kN.
          -. Mry        =      2292.667 kN-m.
          -. Mrz        =      3231.406 kN-m.
          -. Mr         =      3962.109 kN-m.
          -. Pu/Pr      =   0.188  --->  O.K !
          -. Muy/Mry    =   0.187  --->  O.K !
          -. Muz/Mrz    =   0.187  --->  O.K !
          -. Mu/Mr      =   0.188  --->  O.K !
          -. Ratio      =   0.188  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2845.65 kN.
          -. Vuz    =        300.66 kN.
          -. Muy    =       -657.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.48 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.13

          -. Vuy    =        188.93 kN.
          -. Muz    =       -406.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.05
```

( ). Compute shear strength of concrete.
-. Vuz = 300.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1416.23 kN.
-. phiVcz = phi * Vcz = 1274.61 kN.

-. Vuy = 188.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1376.44 kN.
-. phiVcy = phi * Vcy = 1238.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2209.43 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5732.25 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2209.43 kN.
-. phiVsz = phi*Vsz = 1988.49 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2191.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5772.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2191.65 kN.
-. phiVsy = phi*Vsy = 1972.48 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 355.095 kN.
-. Vr = 3211.280 kN.
-. Ratio = Vu / Vr = 0.111 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 394.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 394.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114124,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3241.84      -330.13      -238.77      -464.03      -333.15
           ------------------------------------------------------------------------------
            DL+LL+Others     3241.84      -330.13      -238.77      -464.03      -333.15
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      238.77 kN-m.
           -. End Moments (My2) =      330.13 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -330.13 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -330.13 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      333.15 kN-m.
          -. End Moments (Mz2) =      464.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -464.03 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -464.03 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     19741.003 kN.
          -. Mry        =      2002.458 kN-m.
          -. Mrz        =      2827.614 kN-m.
          -. Mr         =      3464.857 kN-m.
          -. Pu/Pr      =   0.164  --->  O.K !
          -. Muy/Mry    =   0.165  --->  O.K !
          -. Muz/Mrz    =   0.164  --->  O.K !
          -. Mu/Mr      =   0.165  --->  O.K !
          -. Ratio      =   0.165  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2862.32 kN.
          -. Vuz    =        281.37 kN.
          -. Muy    =       -507.28 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.27 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.23

          -. Vuy    =        176.08 kN.
          -. Muz    =       -311.78 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.14
```

( ). Compute shear strength of concrete.
-. Vuz = 281.37 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1457.93 kN.
-. phiVcz = phi * Vcz = 1312.13 kN.

-. Vuy = 176.08 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1419.17 kN.
-. phiVcy = phi * Vcy = 1277.25 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2227.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5690.56 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2227.23 kN.
-. phiVsz = phi*Vsz = 2004.51 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2210.71 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5729.32 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2210.71 kN.
-. phiVsy = phi*Vsy = 1989.64 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 331.923 kN.
-. Vr = 3266.895 kN.
-. Ratio = Vu / Vr = 0.102 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 368.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 368.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114125,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3258.52      -238.77      -159.64      -333.15      -220.67
           ------------------------------------------------------------------------------
            DL+LL+Others     3258.52      -238.77      -159.64      -333.15      -220.67
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      159.64 kN-m.
           -. End Moments (My2) =      238.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -238.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -238.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      220.67 kN-m.
          -. End Moments (Mz2) =      333.15 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -333.15 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -333.15 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     22309.114 kN.
          -. Mry        =      1642.807 kN-m.
          -. Mrz        =      2297.678 kN-m.
          -. Mr         =      2824.560 kN-m.
          -. Pu/Pr      =   0.146  --->  O.K !
          -. Muy/Mry    =   0.145  --->  O.K !
          -. Muz/Mrz    =   0.145  --->  O.K !
          -. Mu/Mr      =   0.146  --->  O.K !
          -. Ratio      =   0.146  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2878.99 kN.
          -. Vuz    =        243.47 kN.
          -. Muy    =       -366.61 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.33

          -. Vuy    =        151.25 kN.
          -. Muz    =       -223.77 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 243.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1503.95 kN.
-. phiVcz = phi * Vcz = 1353.56 kN.

-. Vuy = 151.25 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1466.50 kN.
-. phiVcy = phi * Vcy = 1319.85 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2245.95 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5644.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2245.95 kN.
-. phiVsz = phi*Vsz = 2021.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2230.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5681.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2230.79 kN.
-. phiVsy = phi*Vsy = 2007.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 286.622 kN.
-. Vr = 3327.558 kN.
-. Ratio = Vu / Vr = 0.086 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 318.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 318.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114126,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3291.84      -159.64       -98.01      -220.67      -134.08
           ------------------------------------------------------------------------------
            DL+LL+Others     3291.84      -159.64       -98.01      -220.67      -134.08
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       98.01 kN-m.
           -. End Moments (My2) =      159.64 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -98.01 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -98.01 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      134.08 kN-m.
          -. End Moments (Mz2) =      220.67 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -134.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -134.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       727.455 kN-m.
          -. Mrz        =       993.383 kN-m.
          -. Mr         =      1231.260 kN-m.
          -. Pu/Pr      =   0.135  --->  O.K !
          -. Muy/Mry    =   0.135  --->  O.K !
          -. Muz/Mrz    =   0.135  --->  O.K !
          -. Mu/Mr      =   0.135  --->  O.K !
          -. Ratio      =   0.135  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2895.65 kN.
          -. Vuz    =        189.41 kN.
          -. Muy    =       -244.87 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.43

          -. Vuy    =        116.37 kN.
          -. Muz    =       -148.18 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.01 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.35
```

( ). Compute shear strength of concrete.
-. Vuz = 189.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1551.39 kN.
-. phiVcz = phi * Vcz = 1396.25 kN.

-. Vuy = 116.37 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1515.45 kN.
-. phiVcy = phi * Vcy = 1363.91 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2264.31 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5597.09 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2264.31 kN.
-. phiVsz = phi*Vsz = 2037.88 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2250.49 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5633.04 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2250.49 kN.
-. phiVsy = phi*Vsy = 2025.44 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 222.304 kN.
-. Vr = 3389.347 kN.
-. Ratio = Vu / Vr = 0.066 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 247.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 247.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114127,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3308.51       -98.01       -52.67      -134.08       -71.21
           ------------------------------------------------------------------------------
            DL+LL+Others     3308.51       -98.01       -52.67      -134.08       -71.21
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       52.67 kN-m.
           -. End Moments (My2) =       98.01 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -52.67 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -52.67 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       71.21 kN-m.
          -. End Moments (Mz2) =      134.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -71.21 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -71.21 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       389.026 kN-m.
          -. Mrz        =       524.859 kN-m.
          -. Mr         =       653.313 kN-m.
          -. Pu/Pr      =   0.136  --->  O.K !
          -. Muy/Mry    =   0.135  --->  O.K !
          -. Muz/Mrz    =   0.136  --->  O.K !
          -. Mu/Mr      =   0.136  --->  O.K !
          -. Ratio      =   0.136  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2912.32 kN.
          -. Vuz    =        139.15 kN.
          -. Muy    =       -150.17 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.52

          -. Vuy    =         84.45 kN.
          -. Muz    =        -90.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.45
```

( ). Compute shear strength of concrete.
-. Vuz = 139.15 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1592.11 kN.
-. phiVcz = phi * Vcz = 1432.90 kN.

-. Vuy = 84.45 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1557.60 kN.
-. phiVcy = phi * Vcy = 1401.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2279.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5556.38 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2279.36 kN.
-. phiVsz = phi*Vsz = 2051.42 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2266.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5590.88 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2266.65 kN.
-. phiVsy = phi*Vsy = 2039.98 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 162.768 kN.
-. Vr = 3441.827 kN.
-. Ratio = Vu / Vr = 0.047 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 180.85 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 180.85 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114128,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3325.18       -52.67       -22.22       -71.21       -29.63
           ------------------------------------------------------------------------------
            DL+LL+Others     3325.18       -52.67       -22.22       -71.21       -29.63
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       22.22 kN-m.
           -. End Moments (My2) =       52.67 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -22.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -22.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       29.63 kN-m.
          -. End Moments (Mz2) =       71.21 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -29.63 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -29.63 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       163.353 kN-m.
          -. Mrz        =       217.231 kN-m.
          -. Mr         =       271.797 kN-m.
          -. Pu/Pr      =   0.136  --->  O.K !
          -. Muy/Mry    =   0.136  --->  O.K !
          -. Muz/Mrz    =   0.136  --->  O.K !
          -. Mu/Mr      =   0.136  --->  O.K !
          -. Ratio      =   0.136  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2945.63 kN.
          -. Vuz    =         93.28 kN.
          -. Muy    =        -33.95 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.57 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.59

          -. Vuy    =         55.84 kN.
          -. Muz    =        -19.89 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.70 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.52
```

( ). Compute shear strength of concrete.
-. Vuz = 93.28 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1623.21 kN.
-. phiVcz = phi * Vcz = 1460.89 kN.

-. Vuy = 55.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1589.89 kN.
-. phiVcy = phi * Vcy = 1430.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2290.44 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5525.28 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2290.44 kN.
-. phiVsz = phi*Vsz = 2061.40 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2278.56 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5558.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2278.56 kN.
-. phiVsy = phi*Vsy = 2050.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 108.719 kN.
-. Vr = 3481.605 kN.
-. Ratio = Vu / Vr = 0.031 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 120.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 120.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114129,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3341.84       -22.22        -5.18       -29.63        -6.76
           ------------------------------------------------------------------------------
            DL+LL+Others     3341.84       -22.22        -5.18       -29.63        -6.76
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        5.18 kN-m.
           -. End Moments (My2) =       22.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -5.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -5.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        6.76 kN-m.
          -. End Moments (Mz2) =       29.63 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -6.76 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -6.76 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        37.742 kN-m.
          -. Mrz        =        49.402 kN-m.
          -. Mr         =        62.169 kN-m.
          -. Pu/Pr      =   0.137  --->  O.K !
          -. Muy/Mry    =   0.137  --->  O.K !
          -. Muz/Mrz    =   0.137  --->  O.K !
          -. Mu/Mr      =   0.137  --->  O.K !
          -. Ratio      =   0.137  --->  O.K !

 =======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 =======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2962.29 kN.
          -. Vuz    =         52.12 kN.
          -. Muy    =         -7.89 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.64

          -. Vuy    =         30.71 kN.
          -. Muz    =         -4.54 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 52.12 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1644.77 kN.
-. phiVcz = phi * Vcz = 1480.30 kN.

-. Vuy = 30.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1612.32 kN.
-. phiVcy = phi * Vcy = 1451.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2297.92 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5503.71 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2297.92 kN.
-. phiVsz = phi*Vsz = 2068.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5536.17 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.60 kN.
-. phiVsy = phi*Vsy = 2057.94 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 60.497 kN.
-. Vr = 3509.029 kN.
-. Ratio = Vu / Vr = 0.017 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 67.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 67.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114130,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3358.50        -5.18         0.00        -6.76         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3358.50        -5.18         0.00        -6.76         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        5.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        6.76 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.138  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.138  --->  O.K !
          -. Ratio      =   0.138  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2978.95 kN.
          -. Vuz    =         15.78 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.61

          -. Vuy    =          9.09 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.53 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 15.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1632.25 kN.
-. phiVcz = phi * Vcz = 1469.02 kN.

-. Vuy = 9.09 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1632.25 kN.
-. phiVcy = phi * Vcy = 1469.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2293.59 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5516.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2293.59 kN.
-. phiVsz = phi*Vsz = 2064.23 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2293.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5516.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2293.59 kN.
-. phiVsy = phi*Vsy = 2064.23 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 18.209 kN.
-. Vr = 3533.255 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 20.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 20.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0048 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114202,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -380.97       158.09       394.00       501.07       792.11
           ------------------------------------------------------------------------------
           DL+LL+Others     -380.97       158.09       394.00       501.07       792.11
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1900.836 kN.
          -. Mry        =      1980.630 kN-m.
          -. Mrz        =      3978.092 kN-m.
          -. Mr         =      4443.885 kN-m.
          -. Pu/Pr      =   0.200  --->  O.K !
          -. Muy/Mry    =   0.199  --->  O.K !
          -. Muz/Mrz    =   0.199  --->  O.K !
          -. Mu/Mr      =   0.200  --->  O.K !
          -. Ratio      =   0.200  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2568.69 kN.
          -. Vuz    =        876.07 kN.
          -. Muy    =       -534.11 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89
```

```
          -. Vuy    =       521.05 kN.
          -. Muz    =      -509.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.34 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.80

     ( ). Compute shear strength of concrete.
          -. Vuz       =     876.07 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1305.97 kN.
          -. phiVcz    = phi * Vcz =     1175.37 kN.

          -. Vuy       =     521.05 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1264.06 kN.
          -. phiVcy    = phi * Vcy =     1137.66 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2158.07 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5842.52 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2158.07 kN.
          -. phiVsz   = phi*Vsz =     1942.26 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2136.72 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5884.42 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2136.72 kN.
          -. phiVsy   = phi*Vsy =     1923.05 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1019.312 kN.
          -. Vr       =    3060.710 kN.
          -. Ratio    = Vu / Vr = 0.333  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 1132.57 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 1132.57 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0003 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
- As = 0.0363 m^2.
- As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114203,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -369.07       394.00       631.99       792.11      1070.82
           ---------------------------------------------------------------------------
           DL+LL+Others     -369.07       394.00       631.99       792.11      1070.82
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1364.651 kN.
          -. Mry        =      2332.586 kN-m.
          -. Mrz        =      3956.072 kN-m.
          -. Mr         =      4592.544 kN-m.
          -. Pu/Pr      =   0.270  --->  O.K !
          -. Muy/Mry    =   0.271  --->  O.K !
          -. Muz/Mrz    =   0.271  --->  O.K !
          -. Mu/Mr      =   0.271  --->  O.K !
          -. Ratio      =   0.271  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2585.40 kN.
          -. Vuz    =        779.01 kN.
          -. Muy    =       -886.45 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.83
```

```
          -. Vuy    =       461.14 kN.
          -. Muz    =      -684.30 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.74

     ( ). Compute shear strength of concrete.
          -. Vuz       =     779.01 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1279.75 kN.
          -. phiVcz    = phi * Vcz =     1151.78 kN.

          -. Vuy       =     461.14 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1237.48 kN.
          -. phiVcy    = phi * Vcy =     1113.74 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2144.84 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5868.74 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2144.84 kN.
          -. phiVsz   = phi*Vsz =     1930.36 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2122.60 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5911.00 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2122.60 kN.
          -. phiVsy   = phi*Vsy =     1910.34 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     905.270 kN.
          -. Vr       =    3024.077 kN.
          -. Ratio    = Vu / Vr = 0.299  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1005.86 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1005.86 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114204,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -357.17       631.99       842.92      1070.82      1320.89
           ---------------------------------------------------------------------------
           DL+LL+Others     -357.17       631.99       842.92      1070.82      1320.89
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1071.486 kN.
          -. Mry        =      2508.027 kN-m.
          -. Mrz        =      3928.957 kN-m.
          -. Mr         =      4661.212 kN-m.
          -. Pu/Pr      =   0.333  --->  O.K !
          -. Muy/Mry    =   0.336  --->  O.K !
          -. Muz/Mrz    =   0.336  --->  O.K !
          -. Mu/Mr      =   0.336  --->  O.K !
          -. Ratio      =   0.336  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2602.12 kN.
          -. Vuz    =        682.63 kN.
          -. Muy    =      -1195.47 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74
```

-. Vuy = 401.92 kN.
-. Muz = -858.40 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 32.82 Deg. [Clause 5.8.3.4.2]
-. betay = 2.64

( ). Compute shear strength of concrete.
-. Vuz = 682.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1235.89 kN.
-. phiVcz = phi * Vcz = 1112.30 kN.

-. Vuy = 401.92 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1193.13 kN.
-. phiVcy = phi * Vcy = 1073.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2121.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5912.59 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2121.74 kN.
-. phiVsz = phi*Vsz = 1909.57 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2097.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5955.36 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2097.96 kN.
-. phiVsy = phi*Vsy = 1888.16 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 792.163 kN.
-. Vr = 2961.980 kN.
-. Ratio = Vu / Vr = 0.267 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 880.18 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 880.18 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114205,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -345.26       842.92      1025.62      1320.89      1534.63
           ---------------------------------------------------------------------------
           DL+LL+Others     -345.26       842.92      1025.62      1320.89      1534.63
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -887.562 kN.
          -. Mry        =      2619.376 kN-m.
          -. Mrz        =      3910.663 kN-m.
          -. Mr         =      4706.848 kN-m.
          -. Pu/Pr      =   0.389  --->  O.K !
          -. Muy/Mry    =   0.392  --->  O.K !
          -. Muz/Mrz    =   0.392  --->  O.K !
          -. Mu/Mr      =   0.392  --->  O.K !
          -. Ratio      =   0.392  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2618.83 kN.
          -. Vuz    =        587.93 kN.
          -. Muy    =      -1461.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.76 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.66
```

-. Vuy = 344.01 kN.
-. Muz = -1014.34 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.07 Deg. [Clause 5.8.3.4.2]
-. betay = 2.56

( ). Compute shear strength of concrete.
-. Vuz = 587.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1201.42 kN.
-. phiVcz = phi * Vcz = 1081.28 kN.

-. Vuy = 344.01 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1158.37 kN.
-. phiVcy = phi * Vcy = 1042.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2102.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5947.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2102.67 kN.
-. phiVsz = phi*Vsz = 1892.40 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2077.63 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5990.12 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2077.63 kN.
-. phiVsy = phi*Vsy = 1869.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 681.179 kN.
-. Vr = 2912.402 kN.
-. Ratio = Vu / Vr = 0.234 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 756.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 756.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114206,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -333.35      1025.62      1179.47      1534.63      1711.62
           ---------------------------------------------------------------------------
           DL+LL+Others     -333.35      1025.62      1179.47      1534.63      1711.62
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -752.700 kN.
          -. Mry        =      2695.077 kN-m.
          -. Mrz        =      3900.093 kN-m.
          -. Mr         =      4740.693 kN-m.
          -. Pu/Pr      =   0.443  --->  O.K !
          -. Muy/Mry    =   0.438  --->  O.K !
          -. Muz/Mrz    =   0.439  --->  O.K !
          -. Mu/Mr      =   0.443  --->  O.K !
          -. Ratio      =   0.443  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2635.54 kN.
          -. Vuz    =        495.98 kN.
          -. Muy    =      -1685.67 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.94 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.60
```

-. Vuy = 288.12 kN.
-. Muz = -1147.76 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.27 Deg. [Clause 5.8.3.4.2]
-. betay = 2.51

( ). Compute shear strength of concrete.
-. Vuz = 495.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1175.30 kN.
-. phiVcz = phi * Vcz = 1057.77 kN.

-. Vuy = 288.12 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1132.09 kN.
-. phiVcy = phi * Vcy = 1018.88 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2087.65 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5973.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2087.65 kN.
-. phiVsz = phi*Vsz = 1878.89 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2061.64 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6016.39 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2061.64 kN.
-. phiVsy = phi*Vsy = 1855.48 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 573.592 kN.
-. Vr = 2874.362 kN.
-. Ratio = Vu / Vr = 0.200 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 637.32 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 637.32 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
- As = 0.0363 m^2.
- As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114207,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -321.43      1179.47      1305.38      1711.62      1854.05
           ---------------------------------------------------------------------------
            DL+LL+Others     -321.43      1179.47      1305.38      1711.62      1854.05
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -679.561 kN.
          -. Mry        =      2739.003 kN-m.
          -. Mrz        =      3894.774 kN-m.
          -. Mr         =      4761.450 kN-m.
          -. Pu/Pr      =   0.473  --->  O.K !
          -. Muy/Mry    =   0.477  --->  O.K !
          -. Muz/Mrz    =   0.476  --->  O.K !
          -. Mu/Mr      =   0.477  --->  O.K !
          -. Ratio      =   0.477  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2652.25 kN.
          -. Vuz    =        407.79 kN.
          -. Muy    =      -1868.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56
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```
          -. Vuy    =       234.93 kN.
          -. Muz    =     -1258.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.43 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.46

     ( ). Compute shear strength of concrete.
          -. Vuz       =     407.79 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1156.27 kN.
          -. phiVcz    = phi * Vcz =     1040.64 kN.

          -. Vuy       =     234.93 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1112.97 kN.
          -. phiVcy    = phi * Vcy =     1001.67 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2076.38 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5992.22 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2076.38 kN.
          -. phiVsz   = phi*Vsz =     1868.74 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2049.64 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6035.52 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2049.64 kN.
          -. phiVsy   = phi*Vsy =     1844.68 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     470.627 kN.
          -. Vr       =    2846.352 kN.
          -. Ratio    = Vu / Vr = 0.165  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 522.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 522.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114208,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -309.51      1305.38      1413.69      1854.05      1963.29
           ---------------------------------------------------------------------------
           DL+LL+Others     -309.51      1305.38      1413.69      1854.05      1963.29
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -607.820 kN.
          -. Mry        =      2791.126 kN-m.
          -. Mrz        =      3880.422 kN-m.
          -. Mr         =      4779.964 kN-m.
          -. Pu/Pr      =   0.509  --->  O.K !
          -. Muy/Mry    =   0.506  --->  O.K !
          -. Muz/Mrz    =   0.506  --->  O.K !
          -. Mu/Mr      =   0.509  --->  O.K !
          -. Ratio      =   0.509  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2668.95 kN.
          -. Vuz    =        324.43 kN.
          -. Muy    =      -2021.97 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.53
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```
          -. Vuy    =       185.23 kN.
          -. Muz    =     -1347.37 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.43

     ( ). Compute shear strength of concrete.
          -. Vuz       =     324.43 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1142.25 kN.
          -. phiVcz    = phi * Vcz =     1028.03 kN.

          -. Vuy       =     185.23 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1098.91 kN.
          -. phiVcy    = phi * Vcy =      989.02 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2067.89 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6006.23 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2067.89 kN.
          -. phiVsz   = phi*Vsz =     1861.10 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2040.62 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6049.57 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2040.62 kN.
          -. phiVsy   = phi*Vsy =     1836.56 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     373.586 kN.
          -. Vr       =    2825.579 kN.
          -. Ratio    = Vu / Vr = 0.132  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 415.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 415.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114209,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -297.59      1413.69      1496.37      1963.29      2043.84
           ---------------------------------------------------------------------------
           DL+LL+Others     -297.59      1413.69      1496.37      1963.29      2043.84
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -566.112 kN.
          -. Mry        =      2828.276 kN-m.
          -. Mrz        =      3867.149 kN-m.
          -. Mr         =      4791.032 kN-m.
          -. Pu/Pr      =   0.526  --->  O.K !
          -. Muy/Mry    =   0.529  --->  O.K !
          -. Muz/Mrz    =   0.529  --->  O.K !
          -. Mu/Mr      =   0.529  --->  O.K !
          -. Ratio      =   0.529  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2685.65 kN.
          -. Vuz    =        246.86 kN.
          -. Muy    =      -2138.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51
```

```
          -. Vuy    =       139.79 kN.
          -. Muz    =     -1416.76 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41

     ( ). Compute shear strength of concrete.
          -. Vuz       =     246.86 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1133.34 kN.
          -. phiVcz    = phi * Vcz =     1020.00 kN.

          -. Vuy       =     139.79 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1089.98 kN.
          -. phiVcy    = phi * Vcy =      980.98 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2062.41 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6015.15 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2062.41 kN.
          -. phiVsz   = phi*Vsz =     1856.17 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2034.79 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6058.51 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2034.79 kN.
          -. phiVsy   = phi*Vsy =     1831.31 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     283.693 kN.
          -. Vr       =    2812.292 kN.
          -. Ratio    = Vu / Vr = 0.101  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 315.21 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 315.21 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114210,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -285.67      1496.37      1547.31      2043.84      2087.43
           ---------------------------------------------------------------------------
           DL+LL+Others     -285.67      1496.37      1547.31      2043.84      2087.43
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -523.876 kN.
          -. Mry        =      2857.349 kN-m.
          -. Mrz        =      3859.421 kN-m.
          -. Mr         =      4802.039 kN-m.
          -. Pu/Pr      =   0.545  --->  O.K !
          -. Muy/Mry    =   0.542  --->  O.K !
          -. Muz/Mrz    =   0.541  --->  O.K !
          -. Mu/Mr      =   0.545  --->  O.K !
          -. Ratio      =   0.545  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2702.35 kN.
          -. Vuz    =        154.09 kN.
          -. Muy    =      -2209.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.51
```

```
          -. Vuy    =         87.60 kN.
          -. Muz    =      -1459.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41

     ( ). Compute shear strength of concrete.
          -. Vuz       =      154.09 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1133.54 kN.
          -. phiVcz    = phi * Vcz =     1020.19 kN.

          -. Vuy       =       87.60 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1090.18 kN.
          -. phiVcy    = phi * Vcy =      981.16 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2062.54 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6014.95 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2062.54 kN.
          -. phiVsz   = phi*Vsz =     1856.28 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2034.92 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6058.31 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2034.92 kN.
          -. phiVsy   = phi*Vsy =     1831.43 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     177.250 kN.
          -. Vr       =    2812.594 kN.
          -. Ratio    = Vu / Vr = 0.063  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 196.94 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 196.94 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0042 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114211,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -285.73      1547.31      1557.04      2087.43      2079.69
           ---------------------------------------------------------------------------
           DL+LL+Others     -285.73      1547.31      1557.04      2087.43      2079.69
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      -523.876 kN.
          -. Mry        =      2857.349 kN-m.
          -. Mrz        =      3859.421 kN-m.
          -. Mr         =      4802.039 kN-m.
          -. Pu/Pr      =   0.545  --->  O.K !
          -. Muy/Mry    =   0.542  --->  O.K !
          -. Muz/Mrz    =   0.541  --->  O.K !
          -. Mu/Mr      =   0.545  --->  O.K !
          -. Ratio      =   0.545  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =        126.74 kN.
          -. Vuz    =         29.25 kN.
          -. Muy    =       2264.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.25 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.83
```

```
          -. Vuy    =         55.68 kN.
          -. Muz    =       1436.11 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.25 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.83

     ( ). Compute shear strength of concrete.
          -. Vuz       =       29.25 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1279.04 kN.
          -. phiVcz    = phi * Vcz =     1151.13 kN.

          -. Vuy       =       55.68 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1279.04 kN.
          -. phiVcy    = phi * Vcy =     1151.13 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2144.48 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5869.45 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2144.48 kN.
          -. phiVsz   = phi*Vsz =     1930.03 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2144.48 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5869.45 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2144.48 kN.
          -. phiVsy   = phi*Vsy =     1930.03 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =      62.893 kN.
          -. Vr       =    3081.160 kN.
          -. Ratio    = Vu / Vr = 0.020  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 69.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 69.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0083 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0083 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0083 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114212,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            126.70      2264.38      2226.49      1436.11      1403.43
           ------------------------------------------------------------------------------
            DL+LL+Others      126.70      2264.38      2226.49      1436.11      1403.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2226.49 kN-m.
           -. End Moments (My2) =     2264.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2264.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2264.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1403.43 kN-m.
          -. End Moments (Mz2) =     1436.11 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1436.11 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1436.11 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       234.173 kN.
          -. Mry        =      4208.351 kN-m.
          -. Mrz        =      2661.146 kN-m.
          -. Mr         =      4979.148 kN-m.
          -. Pu/Pr      =   0.541  --->  O.K !
          -. Muy/Mry    =   0.538  --->  O.K !
          -. Muz/Mrz    =   0.540  --->  O.K !
          -. Mu/Mr      =   0.541  --->  O.K !
          -. Ratio      =   0.541  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3119.60 kN.
          -. Vuz    =         67.73 kN.
          -. Muy    =      -1514.79 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.48

          -. Vuy    =        109.00 kN.
          -. Muz    =      -2108.92 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.39
```

( ). Compute shear strength of concrete.
-. Vuz = 67.73 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1121.92 kN.
-. phiVcz = phi * Vcz = 1009.73 kN.

-. Vuy = 109.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1078.54 kN.
-. phiVcy = phi * Vcy = 970.69 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2055.30 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6026.57 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2055.30 kN.
-. phiVsz = phi*Vsz = 1849.77 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2027.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6069.95 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2027.23 kN.
-. phiVsy = phi*Vsy = 1824.50 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 128.327 kN.
-. Vr = 2795.190 kN.
-. Ratio = Vu / Vr = 0.046 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 142.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 142.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114213,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            138.65      2226.49      2143.36      1403.43      1344.21
           ------------------------------------------------------------------------------
            DL+LL+Others      138.65      2226.49      2143.36      1403.43      1344.21
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2143.36 kN-m.
           -. End Moments (My2) =     2226.49 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2226.49 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2226.49 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1344.21 kN-m.
          -. End Moments (Mz2) =     1403.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1403.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1403.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       264.069 kN.
          -. Mry        =      4221.560 kN-m.
          -. Mrz        =      2652.923 kN-m.
          -. Mr         =      4985.937 kN-m.
          -. Pu/Pr      =   0.525  --->  O.K !
          -. Muy/Mry    =   0.527  --->  O.K !
          -. Muz/Mrz    =   0.529  --->  O.K !
          -. Mu/Mr      =   0.529  --->  O.K !
          -. Ratio      =   0.529  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3136.31 kN.
          -. Vuz    =        121.68 kN.
          -. Muy    =      -1486.36 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47

          -. Vuy    =        181.36 kN.
          -. Muz    =      -2060.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 121.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1118.00 kN.
-. phiVcz = phi * Vcz = 1006.20 kN.

-. Vuy = 181.36 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1074.61 kN.
-. phiVcy = phi * Vcy = 967.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2052.83 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6030.49 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2052.83 kN.
-. phiVsz = phi*Vsz = 1847.54 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2024.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6073.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2024.60 kN.
-. phiVsy = phi*Vsy = 1822.14 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 218.394 kN.
-. Vr = 2789.296 kN.
-. Ratio = Vu / Vr = 0.078 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 242.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 242.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114214,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            150.61      2143.36      2023.77      1344.21      1263.85
           ---------------------------------------------------------------------------
            DL+LL+Others      150.61      2143.36      2023.77      1344.21      1263.85
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     2023.77 kN-m.
           -. End Moments (My2) =     2143.36 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2143.36 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2143.36 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1263.85 kN-m.
          -. End Moments (Mz2) =     1344.21 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1344.21 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1344.21 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       297.980 kN.
          -. Mry        =      4233.981 kN-m.
          -. Mrz        =      2647.381 kN-m.
          -. Mr         =      4993.518 kN-m.
          -. Pu/Pr      =   0.505  --->  O.K !
          -. Muy/Mry    =   0.506  --->  O.K !
          -. Muz/Mrz    =   0.508  --->  O.K !
          -. Mu/Mr      =   0.508  --->  O.K !
          -. Ratio      =   0.508  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3153.02 kN.
          -. Vuz    =        165.40 kN.
          -. Muy    =      -1428.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.48

          -. Vuy    =        239.95 kN.
          -. Muz    =      -1973.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.71 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.39
```

( ). Compute shear strength of concrete.
-. Vuz = 165.40 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1122.56 kN.
-. phiVcz = phi * Vcz = 1010.31 kN.

-. Vuy = 239.95 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1079.19 kN.
-. phiVcy = phi * Vcy = 971.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2055.70 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6025.92 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2055.70 kN.
-. phiVsz = phi*Vsz = 1850.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2027.66 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6069.30 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2027.66 kN.
-. phiVsy = phi*Vsy = 1824.89 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 291.433 kN.
-. Vr = 2796.158 kN.
-. Ratio = Vu / Vr = 0.104 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 323.81 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 323.81 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114215,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            162.57      2023.77      1876.70      1263.85      1167.82
           ------------------------------------------------------------------------------
            DL+LL+Others      162.57      2023.77      1876.70      1263.85      1167.82
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1876.70 kN-m.
           -. End Moments (My2) =     2023.77 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     2023.77 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     2023.77 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1167.82 kN-m.
          -. End Moments (Mz2) =     1263.85 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1263.85 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1263.85 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =       339.721 kN.
           -. Mry        =      4246.634 kN-m.
           -. Mrz        =      2644.472 kN-m.
           -. Mr         =      5002.713 kN-m.
           -. Pu/Pr      =   0.479  --->  O.K !
           -. Muy/Mry    =   0.477  --->  O.K !
           -. Muz/Mrz    =   0.478  --->  O.K !
           -. Mu/Mr      =   0.479  --->  O.K !
           -. Ratio      =   0.479  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 151, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2769.17 kN.
           -. Vuz    =        290.39 kN.
           -. Muy    =      -1980.75 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  33.15 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.54

           -. Vuy    =        193.93 kN.
           -. Muz    =      -1301.68 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  33.50 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.44
```

( ). Compute shear strength of concrete.
-. Vuz = 290.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1147.45 kN.
-. phiVcz = phi * Vcz = 1032.70 kN.

-. Vuy = 193.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1104.12 kN.
-. phiVcy = phi * Vcy = 993.71 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2071.06 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6001.04 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2071.06 kN.
-. phiVsz = phi*Vsz = 1863.95 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2043.98 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6044.36 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2043.98 kN.
-. phiVsy = phi*Vsy = 1839.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 349.191 kN.
-. Vr = 2833.297 kN.
-. Ratio = Vu / Vr = 0.123 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 387.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 387.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114216,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            174.53      1876.70      1711.55      1167.82      1061.86
           ------------------------------------------------------------------------------
            DL+LL+Others      174.53      1876.70      1711.55      1167.82      1061.86
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1711.55 kN-m.
           -. End Moments (My2) =     1876.70 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1876.70 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1876.70 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1061.86 kN-m.
          -. End Moments (Mz2) =     1167.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1167.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1167.82 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       392.585 kN.
          -. Mry        =      4255.019 kN-m.
          -. Mrz        =      2641.060 kN-m.
          -. Mr         =      5008.032 kN-m.
          -. Pu/Pr      =   0.445  --->  O.K !
          -. Muy/Mry    =   0.441  --->  O.K !
          -. Muz/Mrz    =   0.442  --->  O.K !
          -. Mu/Mr      =   0.445  --->  O.K !
          -. Ratio      =   0.445  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2785.86 kN.
          -. Vuz    =        324.95 kN.
          -. Muy    =      -1835.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.58

          -. Vuy    =        215.12 kN.
          -. Muz    =      -1205.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.49
```

( ). Compute shear strength of concrete.
-. Vuz = 324.95 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1166.17 kN.
-. phiVcz = phi * Vcz = 1049.55 kN.

-. Vuy = 215.12 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1122.91 kN.
-. phiVcy = phi * Vcy = 1010.62 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2082.28 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5982.32 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2082.28 kN.
-. phiVsz = phi*Vsz = 1874.05 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2055.92 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6025.57 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2055.92 kN.
-. phiVsy = phi*Vsy = 1850.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 389.703 kN.
-. Vr = 2860.951 kN.
-. Ratio = Vu / Vr = 0.136 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 433.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 433.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0031 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0031 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114217,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            186.49      1711.55      1537.43      1061.86       951.41
           ------------------------------------------------------------------------------
            DL+LL+Others      186.49      1711.55      1537.43      1061.86       951.41
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1537.43 kN-m.
           -. End Moments (My2) =     1711.55 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1711.55 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1711.55 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      951.41 kN-m.
          -. End Moments (Mz2) =     1061.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1061.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1061.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       460.377 kN.
          -. Mry        =      4262.958 kN-m.
          -. Mrz        =      2639.335 kN-m.
          -. Mr         =      5013.871 kN-m.
          -. Pu/Pr      =   0.405  --->  O.K !
          -. Muy/Mry    =   0.401  --->  O.K !
          -. Muz/Mrz    =   0.402  --->  O.K !
          -. Mu/Mr      =   0.405  --->  O.K !
          -. Ratio      =   0.405  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2802.54 kN.
          -. Vuz    =        341.83 kN.
          -. Muy    =      -1673.20 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.64

          -. Vuy    =        225.54 kN.
          -. Muz    =      -1098.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.15 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54
```

( ). Compute shear strength of concrete.
-. Vuz = 341.83 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1191.27 kN.
-. phiVcz = phi * Vcz = 1072.14 kN.

-. Vuy = 225.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1148.15 kN.
-. phiVcy = phi * Vcy = 1033.34 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2096.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5957.22 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2096.89 kN.
-. phiVsz = phi*Vsz = 1887.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2071.48 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6000.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2071.48 kN.
-. phiVsy = phi*Vsy = 1864.33 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 409.529 kN.
-. Vr = 2897.671 kN.
-. Ratio = Vu / Vr = 0.141 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 455.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 455.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0025 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114218,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others            198.45      1537.43      1361.10       951.41       840.52
           ------------------------------------------------------------------------------
            DL+LL+Others      198.45      1537.43      1361.10       951.41       840.52
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1361.10 kN-m.
           -. End Moments (My2) =     1537.43 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1537.43 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1537.43 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      840.52 kN-m.
          -. End Moments (Mz2) =      951.41 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      951.41 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      951.41 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =       550.303 kN.
          -. Mry        =      4271.656 kN-m.
          -. Mrz        =      2639.898 kN-m.
          -. Mr         =      5021.564 kN-m.
          -. Pu/Pr      =   0.361  --->  O.K !
          -. Muy/Mry    =   0.360  --->  O.K !
          -. Muz/Mrz    =   0.360  --->  O.K !
          -. Mu/Mr      =   0.361  --->  O.K !
          -. Ratio      =   0.361  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2819.23 kN.
          -. Vuz    =        345.64 kN.
          -. Muy    =      -1502.30 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =        227.53 kN.
          -. Muz    =       -985.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61
```

( ). Compute shear strength of concrete.
-. Vuz = 345.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1221.17 kN.
-. phiVcz = phi * Vcz = 1099.06 kN.

-. Vuy = 227.53 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1178.28 kN.
-. phiVcy = phi * Vcy = 1060.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2113.70 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5927.31 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2113.70 kN.
-. phiVsz = phi*Vsz = 1902.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2089.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5970.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2089.39 kN.
-. phiVsy = phi*Vsy = 1880.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 413.807 kN.
-. Vr = 2940.898 kN.
-. Ratio = Vu / Vr = 0.141 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 459.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 459.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114219,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2835.91     -1329.48     -1160.05      -871.97      -760.66
           ------------------------------------------------------------------------------
            DL+LL+Others     2835.91     -1329.48     -1160.05      -871.97      -760.66
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1160.05 kN-m.
           -. End Moments (My2) =     1329.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1329.48 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1329.48 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      760.66 kN-m.
          -. End Moments (Mz2) =      871.97 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -871.97 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -871.97 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8733.525 kN.
          -. Mry        =      4125.335 kN-m.
          -. Mrz        =      2715.196 kN-m.
          -. Mr         =      4938.692 kN-m.
          -. Pu/Pr      =   0.325  --->  O.K !
          -. Muy/Mry    =   0.322  --->  O.K !
          -. Muz/Mrz    =   0.321  --->  O.K !
          -. Mu/Mr      =   0.325  --->  O.K !
          -. Ratio      =   0.325  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2835.91 kN.
          -. Vuz    =        338.86 kN.
          -. Muy    =      -1329.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        222.70 kN.
          -. Muz    =       -871.97 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.68 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.68
```

( ). Compute shear strength of concrete.
-. Vuz = 338.86 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1254.80 kN.
-. phiVcz = phi * Vcz = 1129.32 kN.

-. Vuy = 222.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1212.23 kN.
-. phiVcy = phi * Vcy = 1091.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2131.85 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5893.69 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2131.85 kN.
-. phiVsz = phi*Vsz = 1918.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2108.74 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5936.26 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2108.74 kN.
-. phiVsy = phi*Vsy = 1897.87 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 405.493 kN.
-. Vr = 2988.873 kN.
-. Ratio = Vu / Vr = 0.136 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 450.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 450.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114220,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2852.59     -1160.05      -995.60      -760.66      -652.70
           ------------------------------------------------------------------------------
            DL+LL+Others     2852.59     -1160.05      -995.60      -760.66      -652.70
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      995.60 kN-m.
           -. End Moments (My2) =     1160.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1160.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1160.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      652.70 kN-m.
          -. End Moments (Mz2) =      760.66 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -760.66 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -760.66 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9991.887 kN.
          -. Mry        =      4037.957 kN-m.
          -. Mrz        =      2656.393 kN-m.
          -. Mr         =      4833.376 kN-m.
          -. Pu/Pr      =   0.285  --->  O.K !
          -. Muy/Mry    =   0.287  --->  O.K !
          -. Muz/Mrz    =   0.286  --->  O.K !
          -. Mu/Mr      =   0.287  --->  O.K !
          -. Ratio      =   0.287  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2852.59 kN.
          -. Vuz    =        328.90 kN.
          -. Muy    =      -1160.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.18 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        215.97 kN.
          -. Muz    =       -760.66 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 328.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1290.16 kN.
-. phiVcz = phi * Vcz = 1161.14 kN.

-. Vuy = 215.97 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1248.03 kN.
-. phiVcy = phi * Vcy = 1123.23 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2150.14 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5858.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2150.14 kN.
-. phiVsz = phi*Vsz = 1935.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2128.26 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5900.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2128.26 kN.
-. phiVsy = phi*Vsy = 1915.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 393.468 kN.
-. Vr = 3038.663 kN.
-. Ratio = Vu / Vr = 0.129 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 437.19 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 437.19 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114221,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2869.27      -995.60      -831.08      -652.70      -544.70
           ------------------------------------------------------------------------------
            DL+LL+Others     2869.27      -995.60      -831.08      -652.70      -544.70
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      831.08 kN-m.
           -. End Moments (My2) =      995.60 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -995.60 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -995.60 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      544.70 kN-m.
          -. End Moments (Mz2) =      652.70 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -652.70 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -652.70 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11314.432 kN.
          -. Mry        =      3941.362 kN-m.
          -. Mrz        =      2578.076 kN-m.
          -. Mr         =      4709.651 kN-m.
          -. Pu/Pr      =   0.254  --->  O.K !
          -. Muy/Mry    =   0.253  --->  O.K !
          -. Muz/Mrz    =   0.253  --->  O.K !
          -. Mu/Mr      =   0.254  --->  O.K !
          -. Ratio      =   0.254  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2869.27 kN.
          -. Vuz    =        329.05 kN.
          -. Muy    =       -995.60 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.93

          -. Vuy    =        216.07 kN.
          -. Muz    =       -652.70 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.22 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 329.05 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1324.49 kN.
-. phiVcz = phi * Vcz = 1192.04 kN.

-. Vuy = 216.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1282.87 kN.
-. phiVcy = phi * Vcy = 1154.59 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2167.17 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5824.00 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2167.17 kN.
-. phiVsz = phi*Vsz = 1950.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2146.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5865.61 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2146.44 kN.
-. phiVsy = phi*Vsy = 1931.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 393.650 kN.
-. Vr = 3086.384 kN.
-. Ratio = Vu / Vr = 0.128 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 437.39 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 437.39 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-8.4330e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-7.6231e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-7.6231e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114222,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3286.59      -563.42      -452.83      -767.29      -615.50
           ------------------------------------------------------------------------------
            DL+LL+Others     3286.59      -563.42      -452.83      -767.29      -615.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      452.83 kN-m.
           -. End Moments (My2) =      563.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -563.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -563.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      615.50 kN-m.
          -. End Moments (Mz2) =      767.29 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -767.29 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -767.29 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     14932.368 kN.
          -. Mry        =      2540.291 kN-m.
          -. Mrz        =      3466.500 kN-m.
          -. Mr         =      4297.639 kN-m.
          -. Pu/Pr      =   0.220  --->  O.K !
          -. Muy/Mry    =   0.222  --->  O.K !
          -. Muz/Mrz    =   0.221  --->  O.K !
          -. Mu/Mr      =   0.222  --->  O.K !
          -. Ratio      =   0.222  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2885.94 kN.
          -. Vuz    =        325.61 kN.
          -. Muy    =       -831.08 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =        213.78 kN.
          -. Muz    =       -544.70 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.92
```

( ). Compute shear strength of concrete.
-. Vuz = 325.61 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1361.44 kN.
-. phiVcz = phi * Vcz = 1225.30 kN.

-. Vuy = 213.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1320.48 kN.
-. phiVcy = phi * Vcy = 1188.44 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2184.73 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5787.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2184.73 kN.
-. phiVsz = phi*Vsz = 1966.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2165.22 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5828.00 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2165.22 kN.
-. phiVsy = phi*Vsy = 1948.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 389.516 kN.
-. Vr = 3137.131 kN.
-. Ratio = Vu / Vr = 0.124 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 432.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 432.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114223,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3303.27      -452.83      -348.88      -615.50      -473.11
           ------------------------------------------------------------------------------
            DL+LL+Others     3303.27      -452.83      -348.88      -615.50      -473.11
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      348.88 kN-m.
           -. End Moments (My2) =      452.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -452.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -452.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      473.11 kN-m.
          -. End Moments (Mz2) =      615.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -615.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -615.50 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     17157.427 kN.
          -. Mry        =      2352.697 kN-m.
          -. Mrz        =      3187.185 kN-m.
          -. Mr         =      3961.481 kN-m.
          -. Pu/Pr      =   0.193  --->  O.K !
          -. Muy/Mry    =   0.192  --->  O.K !
          -. Muz/Mrz    =   0.193  --->  O.K !
          -. Mu/Mr      =   0.193  --->  O.K !
          -. Ratio      =   0.193  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2902.61 kN.
          -. Vuz    =        306.25 kN.
          -. Muy    =       -668.28 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.54 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.11

          -. Vuy    =        200.96 kN.
          -. Muz    =       -437.86 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.02
```

( ). Compute shear strength of concrete.
-. Vuz = 306.25 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1403.52 kN.
-. phiVcz = phi * Vcz = 1263.17 kN.

-. Vuy = 200.96 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1363.44 kN.
-. phiVcy = phi * Vcy = 1227.09 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2203.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5744.97 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2203.84 kN.
-. phiVsz = phi*Vsz = 1983.45 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2185.66 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5785.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2185.66 kN.
-. phiVsy = phi*Vsy = 1967.09 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 366.302 kN.
-. Vr = 3194.186 kN.
-. Ratio = Vu / Vr = 0.115 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 407.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 407.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114224,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3319.95      -348.88      -251.69      -473.11      -340.24
           ------------------------------------------------------------------------------
            DL+LL+Others     3319.95      -348.88      -251.69      -473.11      -340.24
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      251.69 kN-m.
           -. End Moments (My2) =      348.88 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -348.88 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -348.88 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      340.24 kN-m.
          -. End Moments (Mz2) =      473.11 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -473.11 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -473.11 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     19613.588 kN.
          -. Mry        =      2067.914 kN-m.
          -. Mrz        =      2815.627 kN-m.
          -. Mr         =      3493.426 kN-m.
          -. Pu/Pr      =   0.169  --->  O.K !
          -. Muy/Mry    =   0.169  --->  O.K !
          -. Muz/Mrz    =   0.168  --->  O.K !
          -. Mu/Mr      =   0.169  --->  O.K !
          -. Ratio      =   0.169  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2919.29 kN.
          -. Vuz    =        286.45 kN.
          -. Muy    =       -515.15 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.33 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.20

          -. Vuy    =        187.88 kN.
          -. Muz    =       -337.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.53 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.11
```

( ). Compute shear strength of concrete.
-. Vuz = 286.45 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1445.81 kN.
-. phiVcz = phi * Vcz = 1301.23 kN.

-. Vuy = 187.88 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1406.74 kN.
-. phiVcy = phi * Vcy = 1266.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2222.14 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5702.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2222.14 kN.
-. phiVsz = phi*Vsz = 1999.93 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2205.26 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5741.75 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2205.26 kN.
-. phiVsy = phi*Vsy = 1984.73 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 342.567 kN.
-. Vr = 3250.796 kN.
-. Ratio = Vu / Vr = 0.105 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 380.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 380.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114225,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3336.62      -251.69      -167.75      -340.24      -225.86
           ------------------------------------------------------------------------------
            DL+LL+Others     3336.62      -251.69      -167.75      -340.24      -225.86
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      167.75 kN-m.
           -. End Moments (My2) =      251.69 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -251.69 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -251.69 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      225.86 kN-m.
          -. End Moments (Mz2) =      340.24 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -340.24 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -340.24 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     22310.650 kN.
          -. Mry        =      1678.637 kN-m.
          -. Mrz        =      2272.181 kN-m.
          -. Mr         =      2825.001 kN-m.
          -. Pu/Pr      =   0.150  --->  O.K !
          -. Muy/Mry    =   0.150  --->  O.K !
          -. Muz/Mrz    =   0.150  --->  O.K !
          -. Mu/Mr      =   0.150  --->  O.K !
          -. Ratio      =   0.150  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2935.95 kN.
          -. Vuz    =        247.62 kN.
          -. Muy    =       -371.93 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.11 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.30

          -. Vuy    =        162.31 kN.
          -. Muz    =       -243.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.29 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.22
```

( ). Compute shear strength of concrete.
-. Vuz = 247.62 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1492.56 kN.
-. phiVcz = phi * Vcz = 1343.30 kN.

-. Vuy = 162.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1454.77 kN.
-. phiVcy = phi * Vcy = 1309.29 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2241.41 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5655.93 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2241.41 kN.
-. phiVsz = phi*Vsz = 2017.27 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2225.91 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5693.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2225.91 kN.
-. phiVsy = phi*Vsy = 2003.32 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 296.073 kN.
-. Vr = 3312.612 kN.
-. Ratio = Vu / Vr = 0.089 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 328.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 328.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114226,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3353.30      -167.75      -102.63      -225.86      -137.57
           ------------------------------------------------------------------------------
            DL+LL+Others     3353.30      -167.75      -102.63      -225.86      -137.57
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      102.63 kN-m.
           -. End Moments (My2) =      167.75 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -167.75 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -167.75 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      137.57 kN-m.
          -. End Moments (Mz2) =      225.86 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -225.86 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -225.86 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =      1210.491 kN-m.
          -. Mrz        =      1625.780 kN-m.
          -. Mr         =      2026.931 kN-m.
          -. Pu/Pr      =   0.137  --->  O.K !
          -. Muy/Mry    =   0.139  --->  O.K !
          -. Muz/Mrz    =   0.139  --->  O.K !
          -. Mu/Mr      =   0.139  --->  O.K !
          -. Ratio      =   0.139  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2952.62 kN.
          -. Vuz    =        192.34 kN.
          -. Muy    =       -248.12 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.41

          -. Vuy    =        125.98 kN.
          -. Muz    =       -162.41 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.33
```

( ). Compute shear strength of concrete.
-. Vuz = 192.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1540.86 kN.
-. phiVcz = phi * Vcz = 1386.77 kN.

-. Vuy = 125.98 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1504.57 kN.
-. phiVcy = phi * Vcy = 1354.11 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2260.32 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5607.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2260.32 kN.
-. phiVsz = phi*Vsz = 2034.28 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2246.20 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5643.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2246.20 kN.
-. phiVsy = phi*Vsy = 2021.58 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 229.927 kN.
-. Vr = 3375.690 kN.
-. Ratio = Vu / Vr = 0.068 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 255.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 255.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114227,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3386.62      -102.63       -54.94      -137.57       -73.27
           ------------------------------------------------------------------------------
            DL+LL+Others     3386.62      -102.63       -54.94      -137.57       -73.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       54.94 kN-m.
           -. End Moments (My2) =      102.63 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -54.94 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -54.94 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       73.27 kN-m.
          -. End Moments (Mz2) =      137.57 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -73.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -73.27 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       396.566 kN-m.
          -. Mrz        =       527.538 kN-m.
          -. Mr         =       659.970 kN-m.
          -. Pu/Pr      =   0.139  --->  O.K !
          -. Muy/Mry    =   0.139  --->  O.K !
          -. Muz/Mrz    =   0.139  --->  O.K !
          -. Mu/Mr      =   0.139  --->  O.K !
          -. Ratio      =   0.139  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2969.28 kN.
          -. Vuz    =        141.05 kN.
          -. Muy    =       -151.96 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.73 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.50

          -. Vuy    =         92.34 kN.
          -. Muz    =        -99.45 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.87 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.43
```

( ). Compute shear strength of concrete.
-. Vuz = 141.05 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1582.44 kN.
-. phiVcz = phi * Vcz = 1424.20 kN.

-. Vuy = 92.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1547.58 kN.
-. phiVcy = phi * Vcy = 1392.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2275.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5566.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2275.84 kN.
-. phiVsz = phi*Vsz = 2048.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2262.87 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5600.90 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2262.87 kN.
-. phiVsy = phi*Vsy = 2036.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 168.588 kN.
-. Vr = 3429.411 kN.
-. Ratio = Vu / Vr = 0.049 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 187.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 187.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114228,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3403.29       -54.94       -23.08       -73.27       -30.59
           ------------------------------------------------------------------------------
            DL+LL+Others     3403.29       -54.94       -23.08       -73.27       -30.59
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       23.08 kN-m.
           -. End Moments (My2) =       54.94 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -23.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -23.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       30.59 kN-m.
          -. End Moments (Mz2) =       73.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -30.59 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -30.59 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       165.768 kN-m.
          -. Mrz        =       219.146 kN-m.
          -. Mr         =       274.780 kN-m.
          -. Pu/Pr      =   0.139  --->  O.K !
          -. Muy/Mry    =   0.139  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.140  --->  O.K !
          -. Ratio      =   0.140  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3002.60 kN.
          -. Vuz    =         94.38 kN.
          -. Muy    =        -34.25 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.57

          -. Vuy    =         61.76 kN.
          -. Muz    =        -22.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.74 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.50
```

( ). Compute shear strength of concrete.
-. Vuz = 94.38 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1614.41 kN.
-. phiVcz = phi * Vcz = 1452.97 kN.

-. Vuy = 61.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1580.75 kN.
-. phiVcy = phi * Vcy = 1422.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2287.34 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5534.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2287.34 kN.
-. phiVsz = phi*Vsz = 2058.61 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2275.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5567.73 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2275.23 kN.
-. phiVsy = phi*Vsy = 2047.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 112.790 kN.
-. Vr = 3470.381 kN.
-. Ratio = Vu / Vr = 0.033 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 125.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 125.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114229,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3419.95       -23.08        -5.34       -30.59        -7.02
           ------------------------------------------------------------------------------
            DL+LL+Others     3419.95       -23.08        -5.34       -30.59        -7.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        5.34 kN-m.
           -. End Moments (My2) =       23.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -5.34 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -5.34 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        7.02 kN-m.
          -. End Moments (Mz2) =       30.59 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -7.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -7.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        38.048 kN-m.
          -. Mrz        =        50.111 kN-m.
          -. Mr         =        62.919 kN-m.
          -. Pu/Pr      =   0.140  --->  O.K !
          -. Muy/Mry    =   0.140  --->  O.K !
          -. Muz/Mrz    =   0.140  --->  O.K !
          -. Mu/Mr      =   0.140  --->  O.K !
          -. Ratio      =   0.140  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3019.26 kN.
          -. Vuz    =         52.62 kN.
          -. Muy    =         -7.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.62

          -. Vuy    =         34.44 kN.
          -. Muz    =         -5.20 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.55
```

( ). Compute shear strength of concrete.
-. Vuz = 52.62 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1636.57 kN.
-. phiVcz = phi * Vcz = 1472.91 kN.

-. Vuy = 34.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1603.78 kN.
-. phiVcy = phi * Vcy = 1443.40 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2295.09 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5511.92 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2295.09 kN.
-. phiVsz = phi*Vsz = 2065.58 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2283.56 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5544.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2283.56 kN.
-. phiVsy = phi*Vsy = 2055.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 62.889 kN.
-. Vr = 3498.604 kN.
-. Ratio = Vu / Vr = 0.018 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 69.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 69.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0047 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =114230,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3436.61        -5.34         0.00        -7.02         0.00
           ---------------------------------------------------------------------------
            DL+LL+Others     3436.61        -5.34         0.00        -7.02         0.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        5.34 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        7.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.141  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.141  --->  O.K !
          -. Ratio      =   0.141  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3035.92 kN.
          -. Vuz    =         15.88 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.60

          -. Vuy    =         10.41 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.56 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.60
```

( ). Compute shear strength of concrete.
-. Vuz = 15.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1624.34 kN.
-. phiVcz = phi * Vcz = 1461.90 kN.

-. Vuy = 10.41 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1624.34 kN.
-. phiVcy = phi * Vcy = 1461.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2290.83 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5524.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2290.83 kN.
-. phiVsz = phi*Vsz = 2061.75 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2290.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5524.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2290.83 kN.
-. phiVsy = phi*Vsy = 2061.75 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 18.986 kN.
-. Vr = 3523.655 kN.
-. Ratio = Vu / Vr = 0.005 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 21.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 21.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0048 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115102,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1687.64       704.86       836.44       948.11       392.98
           ---------------------------------------------------------------------------
            DL+LL+Others    -1687.64       704.86       836.44       948.11       392.98
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5018.803 kN.
          -. Mry        =      2084.250 kN-m.
          -. Mrz        =      2818.401 kN-m.
          -. Mr         =      3505.350 kN-m.
          -. Pu/Pr      =   0.336  --->  O.K !
          -. Muy/Mry    =   0.338  --->  O.K !
          -. Muz/Mrz    =   0.336  --->  O.K !
          -. Mu/Mr      =   0.338  --->  O.K !
          -. Ratio      =   0.338  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4717.04 kN.
          -. Vuz    =        407.66 kN.
          -. Muy    =       -775.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.48
```

```
          -. Vuy    =       1101.33 kN.
          -. Muz    =       -151.84 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.73 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38

     ( ). Compute shear strength of concrete.
          -. Vuz       =      407.66 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1120.33 kN.
          -. phiVcz    = phi * Vcz =     1008.29 kN.

          -. Vuy       =     1101.33 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1076.94 kN.
          -. phiVcy    = phi * Vcy =      969.25 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2054.29 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6028.16 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2054.29 kN.
          -. phiVsz   = phi*Vsz =     1848.86 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2026.16 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6071.54 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2026.16 kN.
          -. phiVsy   = phi*Vsy =     1823.55 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1174.353 kN.
          -. Vr       =    2792.797 kN.
          -. Ratio    = Vu / Vr = 0.420  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1304.84 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1304.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0028 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115103,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -814.03      1109.73      1378.78       365.83       456.86
           ---------------------------------------------------------------------------
           DL+LL+Others     -814.03      1109.73      1378.78       365.83       456.86
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2414.824 kN.
          -. Mry        =      4092.279 kN-m.
          -. Mrz        =      1341.468 kN-m.
          -. Mr         =      4306.540 kN-m.
          -. Pu/Pr      =   0.337  --->  O.K !
          -. Muy/Mry    =   0.337  --->  O.K !
          -. Muz/Mrz    =   0.341  --->  O.K !
          -. Mu/Mr      =   0.341  --->  O.K !
          -. Ratio      =   0.341  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4733.88 kN.
          -. Vuz    =        382.41 kN.
          -. Muy    =       -925.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.28 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.50
```

```
          -. Vuy    =       1049.90 kN.
          -. Muz    =       -317.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41

     ( ). Compute shear strength of concrete.
          -. Vuz       =      382.41 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1130.78 kN.
          -. phiVcz    = phi * Vcz =     1017.70 kN.

          -. Vuy       =     1049.90 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1087.41 kN.
          -. phiVcy    = phi * Vcy =      978.67 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2060.83 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6017.71 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2060.83 kN.
          -. phiVsz   = phi*Vsz =     1854.74 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2033.11 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6061.07 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2033.11 kN.
          -. phiVsy   = phi*Vsy =     1829.80 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1117.377 kN.
          -. Vr       =    2808.467 kN.
          -. Ratio    = Vu / Vr = 0.398  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1241.53 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1241.53 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115104,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -802.16      1378.78      1619.40       456.86       748.84
           ---------------------------------------------------------------------------
           DL+LL+Others     -802.16      1378.78      1619.40       456.86       748.84
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1982.638 kN.
          -. Mry        =      4013.463 kN-m.
          -. Mrz        =      1862.186 kN-m.
          -. Mr         =      4424.435 kN-m.
          -. Pu/Pr      =   0.405  --->  O.K !
          -. Muy/Mry    =   0.403  --->  O.K !
          -. Muz/Mrz    =   0.402  --->  O.K !
          -. Mu/Mr      =   0.405  --->  O.K !
          -. Ratio      =   0.405  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4750.71 kN.
          -. Vuz    =        339.15 kN.
          -. Muy    =      -1065.69 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42
```

```
          -. Vuy    =       960.12 kN.
          -. Muz    =      -801.18 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.33

     ( ). Compute shear strength of concrete.
          -. Vuz       =      339.15 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1094.53 kN.
          -. phiVcz    = phi * Vcz =      985.08 kN.

          -. Vuy       =      960.12 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1051.15 kN.
          -. phiVcy    = phi * Vcy =      946.03 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2037.77 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6053.96 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2037.77 kN.
          -. phiVsz   = phi*Vsz =     1833.99 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2008.61 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6097.34 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2008.61 kN.
          -. phiVsy   = phi*Vsy =     1807.75 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1018.259 kN.
          -. Vr       =    2753.778 kN.
          -. Ratio    = Vu / Vr = 0.370  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1131.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1131.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115105,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1640.20      1101.73      1222.85       987.37      1406.24
           ---------------------------------------------------------------------------
           DL+LL+Others    -1640.20      1101.73      1222.85       987.37      1406.24
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3532.433 kN.
          -. Mry        =      2605.538 kN-m.
          -. Mrz        =      3016.762 kN-m.
          -. Mr         =      3986.186 kN-m.
          -. Pu/Pr      =   0.464  --->  O.K !
          -. Muy/Mry    =   0.469  --->  O.K !
          -. Muz/Mrz    =   0.466  --->  O.K !
          -. Mu/Mr      =   0.469  --->  O.K !
          -. Ratio      =   0.469  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4767.54 kN.
          -. Vuz    =        297.85 kN.
          -. Muy    =      -1198.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.92 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.34
```

-. Vuy = 872.17 kN.
-. Muz = -1246.83 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.33 Deg. [Clause 5.8.3.4.2]
-. betay = 2.24

( ). Compute shear strength of concrete.
-. Vuz = 297.85 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1055.34 kN.
-. phiVcz = phi * Vcz = 949.81 kN.

-. Vuy = 872.17 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1012.05 kN.
-. phiVcy = phi * Vcy = 910.84 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2011.51 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6093.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2011.51 kN.
-. phiVsz = phi*Vsz = 1810.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1980.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6136.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1980.73 kN.
-. phiVsy = phi*Vsy = 1782.66 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 921.629 kN.
-. Vr = 2693.502 kN.
-. Ratio = Vu / Vr = 0.342 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1024.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1024.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                  Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115106,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1628.37      1222.85      1316.94      1406.24      1749.51
           ---------------------------------------------------------------------------
           DL+LL+Others    -1628.37      1222.85      1316.94      1406.24      1749.51
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3064.730 kN.
          -. Mry        =      2477.790 kN-m.
          -. Mrz        =      3294.626 kN-m.
          -. Mr         =      4122.378 kN-m.
          -. Pu/Pr      =   0.531  --->  O.K !
          -. Muy/Mry    =   0.531  --->  O.K !
          -. Muz/Mrz    =   0.531  --->  O.K !
          -. Mu/Mr      =   0.531  --->  O.K !
          -. Ratio      =   0.531  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4784.36 kN.
          -. Vuz    =        227.14 kN.
          -. Muy    =      -1302.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.14 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

-. Vuy = 716.80 kN.
-. Muz = -1615.71 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.57 Deg. [Clause 5.8.3.4.2]
-. betay = 2.19

( ). Compute shear strength of concrete.
-. Vuz = 227.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1031.46 kN.
-. phiVcz = phi * Vcz = 928.32 kN.

-. Vuy = 716.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 988.28 kN.
-. phiVcy = phi * Vcy = 889.45 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1994.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6117.03 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1994.77 kN.
-. phiVsz = phi*Vsz = 1795.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1962.99 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6160.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1962.99 kN.
-. phiVsy = phi*Vsy = 1766.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 751.930 kN.
-. Vr = 2656.141 kN.
-. Ratio = Vu / Vr = 0.283 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 835.48 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 835.48 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115107,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1616.54      1316.94      1375.98      1749.51      2011.14
           ---------------------------------------------------------------------------
           DL+LL+Others    -1616.54      1316.94      1375.98      1749.51      2011.14
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2765.554 kN.
          -. Mry        =      2372.258 kN-m.
          -. Mrz        =      3474.435 kN-m.
          -. Mr         =      4207.054 kN-m.
          -. Pu/Pr      =   0.585  --->  O.K !
          -. Muy/Mry    =   0.580  --->  O.K !
          -. Muz/Mrz    =   0.579  --->  O.K !
          -. Mu/Mr      =   0.585  --->  O.K !
          -. Ratio      =   0.585  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4801.17 kN.
          -. Vuz    =        154.39 kN.
          -. Muy    =      -1370.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.27 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

```
          -. Vuy    =       547.99 kN.
          -. Muz    =     -1901.37 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.71 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.16

     ( ). Compute shear strength of concrete.
          -. Vuz       =     154.39 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1018.32 kN.
          -. phiVcz    = phi * Vcz =      916.48 kN.

          -. Vuy       =     547.99 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      975.21 kN.
          -. phiVcy    = phi * Vcy =      877.69 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1985.31 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6130.17 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1985.31 kN.
          -. phiVsz   = phi*Vsz =     1786.78 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1952.96 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6173.28 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1952.96 kN.
          -. phiVsy   = phi*Vsy =     1757.67 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     569.325 kN.
          -. Vr       =    2635.358 kN.
          -. Ratio    = Vu / Vr = 0.216  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 632.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 632.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115108,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1604.69      1375.98      1400.18      2011.14      2190.29
           ---------------------------------------------------------------------------
           DL+LL+Others    -1604.69      1375.98      1400.18      2011.14      2190.29
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2624.555 kN.
          -. Mry        =      2287.622 kN-m.
          -. Mrz        =      3579.504 kN-m.
          -. Mr         =      4248.066 kN-m.
          -. Pu/Pr      =   0.611  --->  O.K !
          -. Muy/Mry    =   0.612  --->  O.K !
          -. Muz/Mrz    =   0.612  --->  O.K !
          -. Mu/Mr      =   0.612  --->  O.K !
          -. Ratio      =   0.612  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4817.98 kN.
          -. Vuz    =         90.59 kN.
          -. Muy    =      -1402.36 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

```
          -. Vuy    =       380.03 kN.
          -. Muz    =     -2102.66 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.15

     ( ). Compute shear strength of concrete.
          -. Vuz       =      90.59 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1014.33 kN.
          -. phiVcz    = phi * Vcz =      912.89 kN.

          -. Vuy       =     380.03 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      971.25 kN.
          -. phiVcy    = phi * Vcy =      874.12 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1982.40 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6134.16 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1982.40 kN.
          -. phiVsz   = phi*Vsz =     1784.16 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1949.88 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6177.24 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1949.88 kN.
          -. phiVsy   = phi*Vsy =     1754.90 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     390.673 kN.
          -. Vr       =    2629.016 kN.
          -. Ratio    = Vu / Vr = 0.149  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 434.08 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 434.08 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115109,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1592.85      1400.18      1391.12      2190.29      2289.74
           ---------------------------------------------------------------------------
           DL+LL+Others    -1592.85      1400.18      1391.12      2190.29      2289.74
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2558.546 kN.
          -. Mry        =      2219.126 kN-m.
          -. Mrz        =      3645.732 kN-m.
          -. Mr         =      4268.007 kN-m.
          -. Pu/Pr      =   0.623  --->  O.K !
          -. Muy/Mry    =   0.627  --->  O.K !
          -. Muz/Mrz    =   0.628  --->  O.K !
          -. Mu/Mr      =   0.628  --->  O.K !
          -. Ratio      =   0.628  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4834.78 kN.
          -. Vuz    =         56.21 kN.
          -. Muy    =      -1399.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.27 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

```
          -. Vuy    =       218.56 kN.
          -. Muz    =     -2222.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.71 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.16

     ( ). Compute shear strength of concrete.
          -. Vuz       =      56.21 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1018.35 kN.
          -. phiVcz    = phi * Vcz =      916.51 kN.

          -. Vuy       =     218.56 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      975.24 kN.
          -. phiVcy    = phi * Vcy =      877.72 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1985.33 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6130.14 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1985.33 kN.
          -. phiVsz   = phi*Vsz =     1786.80 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1952.99 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6173.25 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1952.99 kN.
          -. phiVsy   = phi*Vsy =     1757.69 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     225.677 kN.
          -. Vr       =    2635.404 kN.
          -. Ratio    = Vu / Vr = 0.086  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 250.75 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 250.75 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
- As = 0.0363 m^2.
- As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115110,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1592.98      1391.12      1351.44      2289.74      2314.92
           ---------------------------------------------------------------------------
           DL+LL+Others    -1592.98      1391.12      1351.44      2289.74      2314.92
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2558.546 kN.
          -. Mry        =      2219.126 kN-m.
          -. Mrz        =      3645.732 kN-m.
          -. Mr         =      4268.007 kN-m.
          -. Pu/Pr      =   0.623  --->  O.K !
          -. Muy/Mry    =   0.627  --->  O.K !
          -. Muz/Mrz    =   0.628  --->  O.K !
          -. Mu/Mr      =   0.628  --->  O.K !
          -. Ratio      =   0.628  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       -742.83 kN.
          -. Vuz    =        123.54 kN.
          -. Muy    =       2157.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96
```

```
          -. Vuy    =         80.77 kN.
          -. Muz    =       1602.01 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.90 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96

     ( ). Compute shear strength of concrete.
          -. Vuz       =      123.54 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1337.36 kN.
          -. phiVcz    = phi * Vcz =     1203.62 kN.

          -. Vuy       =       80.77 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1337.36 kN.
          -. phiVcy    = phi * Vcy =     1203.62 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2173.37 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5811.13 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2173.37 kN.
          -. phiVsz   = phi*Vsz =     1956.03 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2173.37 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5811.13 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2173.37 kN.
          -. phiVsy   = phi*Vsy =     1956.03 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     147.603 kN.
          -. Vr       =    3159.654 kN.
          -. Ratio    = Vu / Vr = 0.047  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.90
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 164.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 164.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0097 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0097 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0097 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115111,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1581.12      1351.44      1286.48      2314.92      2276.93
           ------------------------------------------------------------------------------
           DL+LL+Others    -1581.12      1351.44      1286.48      2314.92      2276.93
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2529.084 kN.
          -. Mry        =      2162.838 kN-m.
          -. Mrz        =      3690.481 kN-m.
          -. Mr         =      4277.560 kN-m.
          -. Pu/Pr      =   0.625  --->  O.K !
          -. Muy/Mry    =   0.625  --->  O.K !
          -. Muz/Mrz    =   0.627  --->  O.K !
          -. Mu/Mr      =   0.627  --->  O.K !
          -. Ratio      =   0.627  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4001.50 kN.
          -. Vuz    =        191.94 kN.
          -. Muy    =      -2115.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

```
          -. Vuy    =         36.65 kN.
          -. Muz    =      -1563.72 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.27 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.26

     ( ). Compute shear strength of concrete.
          -. Vuz       =      191.94 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1062.11 kN.
          -. phiVcz    = phi * Vcz =      955.90 kN.

          -. Vuy       =       36.65 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1018.80 kN.
          -. phiVcy    = phi * Vcy =      916.92 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2016.15 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6086.37 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2016.15 kN.
          -. phiVsz   = phi*Vsz =     1814.53 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1985.66 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6129.69 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1985.66 kN.
          -. phiVsy   = phi*Vsy =     1787.09 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     195.402 kN.
          -. Vr       =    2704.009 kN.
          -. Ratio    = Vu / Vr = 0.072  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 217.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 217.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115112,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1569.25      1286.48      1202.43      2276.93      2188.97
           ---------------------------------------------------------------------------
           DL+LL+Others    -1569.25      1286.48      1202.43      2276.93      2188.97
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2568.005 kN.
          -. Mry        =      2107.211 kN-m.
          -. Mrz        =      3710.409 kN-m.
          -. Mr         =      4267.021 kN-m.
          -. Pu/Pr      =   0.611  --->  O.K !
          -. Muy/Mry    =   0.611  --->  O.K !
          -. Muz/Mrz    =   0.614  --->  O.K !
          -. Mu/Mr      =   0.614  --->  O.K !
          -. Ratio      =   0.614  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4018.24 kN.
          -. Vuz    =        252.42 kN.
          -. Muy    =      -2022.86 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

```
          -. Vuy    =       105.44 kN.
          -. Muz    =     -1547.91 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.26 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.26

     ( ). Compute shear strength of concrete.
          -. Vuz       =      252.42 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1063.17 kN.
          -. phiVcz    = phi * Vcz =      956.85 kN.

          -. Vuy       =      105.44 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1019.85 kN.
          -. phiVcy    = phi * Vcy =      917.86 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2016.87 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6085.32 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2016.87 kN.
          -. phiVsz   = phi*Vsz =     1815.18 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1986.42 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6128.64 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1986.42 kN.
          -. phiVsy   = phi*Vsy =     1787.78 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     273.559 kN.
          -. Vr       =    2705.641 kN.
          -. Ratio    = Vu / Vr = 0.101  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 303.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 303.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115113,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1557.37      1202.43      1104.48      2188.97      2062.17
           ---------------------------------------------------------------------------
           DL+LL+Others    -1557.37      1202.43      1104.48      2188.97      2062.17
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2641.412 kN.
          -. Mry        =      2053.361 kN-m.
          -. Mrz        =      3716.892 kN-m.
          -. Mr         =      4246.360 kN-m.
          -. Pu/Pr      =   0.590  --->  O.K !
          -. Muy/Mry    =   0.586  --->  O.K !
          -. Muz/Mrz    =   0.589  --->  O.K !
          -. Mu/Mr      =   0.590  --->  O.K !
          -. Ratio      =   0.590  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4034.98 kN.
          -. Vuz    =        298.80 kN.
          -. Muy    =      -1897.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.37
```

```
          -. Vuy    =       161.11 kN.
          -. Muz    =     -1496.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.18 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.28

     ( ). Compute shear strength of concrete.
          -. Vuz       =     298.80 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1071.17 kN.
          -. phiVcz    = phi * Vcz =      964.05 kN.

          -. Vuy       =     161.11 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1027.83 kN.
          -. phiVcy    = phi * Vcy =      925.04 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2022.29 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6077.31 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2022.29 kN.
          -. phiVsz   = phi*Vsz =     1820.06 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1992.17 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6120.66 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1992.17 kN.
          -. phiVsy   = phi*Vsy =     1792.96 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     339.466 kN.
          -. Vr       =    2718.002 kN.
          -. Ratio    = Vu / Vr = 0.125  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 377.18 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 377.18 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0017 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0017 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0017 m^2.
- As = 0.0363 m^2.
- As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115114,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1545.49      1104.48       997.28      2062.17      1907.70
           ---------------------------------------------------------------------------
           DL+LL+Others    -1545.49      1104.48       997.28      2062.17      1907.70
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2783.914 kN.
          -. Mry        =      1992.961 kN-m.
          -. Mrz        =      3703.002 kN-m.
          -. Mr         =      4205.249 kN-m.
          -. Pu/Pr      =   0.555  --->  O.K !
          -. Muy/Mry    =   0.554  --->  O.K !
          -. Muz/Mrz    =   0.557  --->  O.K !
          -. Mu/Mr      =   0.557  --->  O.K !
          -. Ratio      =   0.557  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4051.71 kN.
          -. Vuz    =        330.46 kN.
          -. Muy    =      -1749.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.66 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.40
```

```
          -. Vuy    =       202.92 kN.
          -. Muz    =     -1416.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.31

     ( ). Compute shear strength of concrete.
          -. Vuz       =     330.46 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1085.62 kN.
          -. phiVcz    = phi * Vcz =      977.06 kN.

          -. Vuy       =     202.92 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1042.25 kN.
          -. phiVcy    = phi * Vcy =      938.02 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2031.92 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6062.87 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2031.92 kN.
          -. phiVsz   = phi*Vsz =     1828.73 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2002.40 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6106.24 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2002.40 kN.
          -. phiVsy   = phi*Vsy =     1802.16 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     387.783 kN.
          -. Vr       =    2740.181 kN.
          -. Ratio    = Vu / Vr = 0.142  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 430.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 430.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115115,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1533.60       997.28       885.15      1907.70      1735.77
           ---------------------------------------------------------------------------
           DL+LL+Others    -1533.60       997.28       885.15      1907.70      1735.77
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2963.113 kN.
          -. Mry        =      1928.405 kN-m.
          -. Mrz        =      3678.470 kN-m.
          -. Mr         =      4153.298 kN-m.
          -. Pu/Pr      =   0.518  --->  O.K !
          -. Muy/Mry    =   0.517  --->  O.K !
          -. Muz/Mrz    =   0.519  --->  O.K !
          -. Mu/Mr      =   0.519  --->  O.K !
          -. Ratio      =   0.519  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4068.44 kN.
          -. Vuz    =        348.15 kN.
          -. Muy    =      -1584.45 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.45
```

```
          -. Vuy    =       230.02 kN.
          -. Muz    =     -1316.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.86 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.35

     ( ). Compute shear strength of concrete.
          -. Vuz       =      348.15 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1105.76 kN.
          -. phiVcz    = phi * Vcz =      995.19 kN.

          -. Vuy       =      230.02 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1062.37 kN.
          -. phiVcy    = phi * Vcy =      956.14 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2045.04 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6042.72 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2045.04 kN.
          -. phiVsz   = phi*Vsz =     1840.53 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2016.33 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6086.11 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2016.33 kN.
          -. phiVsy   = phi*Vsy =     1814.69 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     417.270 kN.
          -. Vr       =    2770.831 kN.
          -. Ratio    = Vu / Vr = 0.151  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 463.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 463.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115116,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1521.70       885.15       770.84      1735.77      1552.28
           ---------------------------------------------------------------------------
           DL+LL+Others    -1521.70       885.15       770.84      1735.77      1552.28
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3216.240 kN.
          -. Mry        =      1851.065 kN-m.
          -. Mrz        =      3635.300 kN-m.
          -. Mr         =      4079.442 kN-m.
          -. Pu/Pr      =   0.473  --->  O.K !
          -. Muy/Mry    =   0.478  --->  O.K !
          -. Muz/Mrz    =   0.477  --->  O.K !
          -. Mu/Mr      =   0.478  --->  O.K !
          -. Ratio      =   0.478  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4935.52 kN.
          -. Vuz    =        230.84 kN.
          -. Muy    =       -905.59 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.37
```

```
          -. Vuy    =       359.13 kN.
          -. Muz    =     -1741.13 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.27

     ( ). Compute shear strength of concrete.
          -. Vuz       =     230.84 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1069.90 kN.
          -. phiVcz    = phi * Vcz =      962.91 kN.

          -. Vuy       =     359.13 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1026.56 kN.
          -. phiVcy    = phi * Vcy =      923.91 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2021.44 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6078.58 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2021.44 kN.
          -. phiVsz   = phi*Vsz =     1819.29 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1991.27 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6121.92 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1991.27 kN.
          -. phiVsy   = phi*Vsy =     1792.14 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     426.921 kN.
          -. Vr       =    2716.048 kN.
          -. Ratio    = Vu / Vr = 0.157  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 474.36 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 474.36 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115117,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1509.80       770.84       656.53      1552.28      1361.87
           ---------------------------------------------------------------------------
           DL+LL+Others    -1509.80       770.84       656.53      1552.28      1361.87
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3505.082 kN.
          -. Mry        =      1772.274 kN-m.
          -. Mrz        =      3582.755 kN-m.
          -. Mr         =      3997.135 kN-m.
          -. Pu/Pr      =   0.431  --->  O.K !
          -. Muy/Mry    =   0.435  --->  O.K !
          -. Muz/Mrz    =   0.433  --->  O.K !
          -. Mu/Mr      =   0.435  --->  O.K !
          -. Ratio      =   0.435  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4952.27 kN.
          -. Vuz    =        231.55 kN.
          -. Muy    =       -790.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42
```

```
          -. Vuy    =       374.31 kN.
          -. Muz    =     -1563.79 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.97 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.32

     ( ). Compute shear strength of concrete.
          -. Vuz       =     231.55 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1093.68 kN.
          -. phiVcz    = phi * Vcz =      984.31 kN.

          -. Vuy       =     374.31 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1050.30 kN.
          -. phiVcy    = phi * Vcy =      945.27 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2037.22 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6054.81 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2037.22 kN.
          -. phiVsz   = phi*Vsz =     1833.49 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2008.02 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6098.19 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2008.02 kN.
          -. phiVsy   = phi*Vsy =     1807.22 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     440.139 kN.
          -. Vr       =    2752.486 kN.
          -. Ratio    = Vu / Vr = 0.160  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 489.04 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 489.04 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0017 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115118,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1497.89       656.53       544.35      1361.87      1167.87
           ---------------------------------------------------------------------------
           DL+LL+Others    -1497.89       656.53       544.35      1361.87      1167.87
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3854.346 kN.
          -. Mry        =      1684.843 kN-m.
          -. Mrz        =      3500.238 kN-m.
          -. Mr         =      3884.632 kN-m.
          -. Pu/Pr      =   0.389  --->  O.K !
          -. Muy/Mry    =   0.390  --->  O.K !
          -. Muz/Mrz    =   0.389  --->  O.K !
          -. Mu/Mr      =   0.390  --->  O.K !
          -. Ratio      =   0.390  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4969.00 kN.
          -. Vuz    =        228.00 kN.
          -. Muy    =       -675.61 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.48
```

-. Vuy = 383.03 kN.
-. Muz = -1378.43 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.73 Deg. [Clause 5.8.3.4.2]
-. betay = 2.38

( ). Compute shear strength of concrete.
-. Vuz = 228.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1120.35 kN.
-. phiVcz = phi * Vcz = 1008.32 kN.

-. Vuy = 383.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1076.97 kN.
-. phiVcy = phi * Vcy = 969.27 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2054.31 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6028.13 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2054.31 kN.
-. phiVsz = phi*Vsz = 1848.88 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2026.18 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6071.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2026.18 kN.
-. phiVsy = phi*Vsy = 1823.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 445.756 kN.
-. Vr = 2792.838 kN.
-. Ratio = Vu / Vr = 0.160 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 495.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 495.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115119,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1485.97       544.35       440.31      1167.87       975.78
           ---------------------------------------------------------------------------
           DL+LL+Others    -1485.97       544.35       440.31      1167.87       975.78
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4292.694 kN.
          -. Mry        =      1581.005 kN-m.
          -. Mrz        =      3391.147 kN-m.
          -. Mr         =      3741.584 kN-m.
          -. Pu/Pr      =   0.346  --->  O.K !
          -. Muy/Mry    =   0.344  --->  O.K !
          -. Muz/Mrz    =   0.344  --->  O.K !
          -. Mu/Mr      =   0.346  --->  O.K !
          -. Ratio      =   0.346  --->  O.K !

 =======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 =======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4985.73 kN.
          -. Vuz    =        212.48 kN.
          -. Muy    =       -562.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.13 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.55
```

```
          -. Vuy    =       382.07 kN.
          -. Muz    =     -1188.22 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.47 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.45

     ( ). Compute shear strength of concrete.
          -. Vuz       =     212.48 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1150.54 kN.
          -. phiVcz    = phi * Vcz =     1035.49 kN.

          -. Vuy       =     382.07 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1107.23 kN.
          -. phiVcy    = phi * Vcy =      996.50 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2072.93 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5997.95 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2072.93 kN.
          -. phiVsz   = phi*Vsz =     1865.64 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2045.98 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6041.26 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2045.98 kN.
          -. phiVsy   = phi*Vsy =     1841.38 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     437.176 kN.
          -. Vr       =    2837.882 kN.
          -. Ratio    = Vu / Vr = 0.154  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 485.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 485.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0031 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115120,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1474.05       440.31       346.65       975.78       793.28
           ---------------------------------------------------------------------------
           DL+LL+Others    -1474.05       440.31       346.65       975.78       793.28
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4877.442 kN.
          -. Mry        =      1458.201 kN-m.
          -. Mrz        =      3236.154 kN-m.
          -. Mr         =      3549.513 kN-m.
          -. Pu/Pr      =   0.302  --->  O.K !
          -. Muy/Mry    =   0.302  --->  O.K !
          -. Muz/Mrz    =   0.302  --->  O.K !
          -. Mu/Mr      =   0.302  --->  O.K !
          -. Ratio      =   0.302  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5002.46 kN.
          -. Vuz    =        192.17 kN.
          -. Muy    =       -456.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62
```

```
          -. Vuy    =        366.00 kN.
          -. Muz    =       -997.62 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.20 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.52

     ( ). Compute shear strength of concrete.
          -. Vuz       =      192.17 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1183.89 kN.
          -. phiVcz    = phi * Vcz =     1065.50 kN.

          -. Vuy       =      366.00 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1140.73 kN.
          -. phiVcy    = phi * Vcy =     1026.65 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2092.64 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5964.60 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2092.64 kN.
          -. phiVsz   = phi*Vsz =     1883.38 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2066.96 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6007.76 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2066.96 kN.
          -. phiVsy   = phi*Vsy =     1860.26 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     413.382 kN.
          -. Vr       =    2886.915 kN.
          -. Ratio    = Vu / Vr = 0.143  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 459.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 459.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115121,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1462.12       346.65       264.63       793.28       625.44
           ---------------------------------------------------------------------------
           DL+LL+Others    -1462.12       346.65       264.63       793.28       625.44
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5587.862 kN.
          -. Mry        =      1317.282 kN-m.
          -. Mrz        =      3041.776 kN-m.
          -. Mr         =      3314.760 kN-m.
          -. Pu/Pr      =   0.262  --->  O.K !
          -. Muy/Mry    =   0.263  --->  O.K !
          -. Muz/Mrz    =   0.261  --->  O.K !
          -. Mu/Mr      =   0.263  --->  O.K !
          -. Ratio      =   0.263  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5019.18 kN.
          -. Vuz    =        169.07 kN.
          -. Muy    =       -360.68 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70
```

```
          -. Vuy    =       339.28 kN.
          -. Muz    =      -814.83 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.60

     ( ). Compute shear strength of concrete.
          -. Vuz       =     169.07 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1218.85 kN.
          -. phiVcz    = phi * Vcz =     1096.97 kN.

          -. Vuy       =     339.28 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1175.94 kN.
          -. phiVcy    = phi * Vcy =     1058.34 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2112.42 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5929.63 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2112.42 kN.
          -. phiVsz   = phi*Vsz =     1901.18 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2088.02 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5972.55 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2088.02 kN.
          -. phiVsy   = phi*Vsy =     1879.22 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     379.074 kN.
          -. Vr       =    2937.564 kN.
          -. Ratio    = Vu / Vr = 0.129  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 421.19 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 421.19 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115122,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5035.89      -276.41      -204.23      -645.37      -493.02
           ------------------------------------------------------------------------------
            DL+LL+Others     5035.89      -276.41      -204.23      -645.37      -493.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      204.23 kN-m.
           -. End Moments (My2) =      276.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -276.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -276.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      493.02 kN-m.
          -. End Moments (Mz2) =      645.37 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -645.37 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -645.37 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     21649.986 kN.
          -. Mry        =      1182.344 kN-m.
          -. Mrz        =      2763.778 kN-m.
          -. Mr         =      3006.062 kN-m.
          -. Pu/Pr      =   0.233  --->  O.K !
          -. Muy/Mry    =   0.234  --->  O.K !
          -. Muz/Mrz    =   0.234  --->  O.K !
          -. Mu/Mr      =   0.234  --->  O.K !
          -. Ratio      =   0.234  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5035.89 kN.
          -. Vuz    =        144.76 kN.
          -. Muy    =       -276.41 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        304.93 kN.
          -. Muz    =       -645.37 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.69 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.68
```

( ). Compute shear strength of concrete.
-. Vuz = 144.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1254.16 kN.
-. phiVcz = phi * Vcz = 1128.74 kN.

-. Vuy = 304.93 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1211.58 kN.
-. phiVcy = phi * Vcy = 1090.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2131.51 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5894.33 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2131.51 kN.
-. phiVsz = phi*Vsz = 1918.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2108.38 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5936.90 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2108.38 kN.
-. phiVsy = phi*Vsy = 1897.54 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 337.542 kN.
-. Vr = 2987.967 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 375.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 375.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115123,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5052.59      -204.23      -144.19      -493.02      -360.16
           ---------------------------------------------------------------------------
            DL+LL+Others     5052.59      -204.23      -144.19      -493.02      -360.16
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      144.19 kN-m.
           -. End Moments (My2) =      204.23 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -204.23 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -204.23 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      360.16 kN-m.
          -. End Moments (Mz2) =      493.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -493.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -493.02 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     23481.080 kN.
          -. Mry        =       952.438 kN-m.
          -. Mrz        =      2284.041 kN-m.
          -. Mr         =      2474.667 kN-m.
          -. Pu/Pr      =   0.215  --->  O.K !
          -. Muy/Mry    =   0.214  --->  O.K !
          -. Muz/Mrz    =   0.216  --->  O.K !
          -. Mu/Mr      =   0.216  --->  O.K !
          -. Ratio      =   0.216  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5052.59 kN.
          -. Vuz    =        120.36 kN.
          -. Muy    =       -204.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.19 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.85

          -. Vuy    =        265.76 kN.
          -. Muz    =       -493.02 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.45 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 120.36 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1288.58 kN.
-. phiVcz = phi * Vcz = 1159.72 kN.

-. Vuy = 265.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1246.43 kN.
-. phiVcy = phi * Vcy = 1121.79 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2149.34 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5859.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2149.34 kN.
-. phiVsz = phi*Vsz = 1934.41 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2127.41 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5902.06 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2127.41 kN.
-. phiVsy = phi*Vsy = 1914.67 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 291.743 kN.
-. Vr = 3036.455 kN.
-. Ratio = Vu / Vr = 0.096 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 324.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 324.16 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0059 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0059 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0059 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115124,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5085.94      -144.19       -95.87      -360.16      -248.06
           ------------------------------------------------------------------------------
            DL+LL+Others     5085.94      -144.19       -95.87      -360.16      -248.06
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       95.87 kN-m.
           -. End Moments (My2) =      144.19 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -95.87 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -95.87 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      248.06 kN-m.
          -. End Moments (Mz2) =      360.16 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -248.06 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -248.06 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       460.641 kN-m.
          -. Mrz        =      1190.050 kN-m.
          -. Mr         =      1276.092 kN-m.
          -. Pu/Pr      =   0.208  --->  O.K !
          -. Muy/Mry    =   0.208  --->  O.K !
          -. Muz/Mrz    =   0.208  --->  O.K !
          -. Mu/Mr      =   0.208  --->  O.K !
          -. Ratio      =   0.208  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5069.29 kN.
          -. Vuz    =         96.84 kN.
          -. Muy    =       -144.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.99 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.92

          -. Vuy    =        224.21 kN.
          -. Muz    =       -360.16 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.24 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.83
```

( ). Compute shear strength of concrete.
-. Vuz = 96.84 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1321.00 kN.
-. phiVcz = phi * Vcz = 1188.90 kN.

-. Vuy = 224.21 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1279.33 kN.
-. phiVcy = phi * Vcy = 1151.40 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2165.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5827.49 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2165.47 kN.
-. phiVsz = phi*Vsz = 1948.92 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2144.63 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5869.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2144.63 kN.
-. phiVsy = phi*Vsy = 1930.17 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 244.231 kN.
-. Vr = 3081.565 kN.
-. Ratio = Vu / Vr = 0.079 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 271.37 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 271.37 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0064 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0064 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0064 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115125,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5102.63       -95.87       -58.55      -248.06      -157.17
           ------------------------------------------------------------------------------
            DL+LL+Others     5102.63       -95.87       -58.55      -248.06      -157.17
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       58.55 kN-m.
           -. End Moments (My2) =       95.87 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -58.55 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -58.55 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      157.17 kN-m.
          -. End Moments (Mz2) =      248.06 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -157.17 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -157.17 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     24404.708 kN.
           -. Mry        =       280.112 kN-m.
           -. Mrz        =       751.662 kN-m.
           -. Mr         =       802.159 kN-m.
           -. Pu/Pr      =   0.209  --->  O.K !
           -. Muy/Mry    =   0.209  --->  O.K !
           -. Muz/Mrz    =   0.209  --->  O.K !
           -. Mu/Mr      =   0.209  --->  O.K !
           -. Ratio      =   0.209  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       5085.98 kN.
           -. Vuz    =         74.78 kN.
           -. Muy    =        -95.87 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.83 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.99

           -. Vuy    =        181.78 kN.
           -. Muz    =       -248.06 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.06 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.90
```

( ). Compute shear strength of concrete.
-. Vuz = 74.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1350.52 kN.
-. phiVcz = phi * Vcz = 1215.47 kN.

-. Vuy = 181.78 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1309.36 kN.
-. phiVcy = phi * Vcy = 1178.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2179.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5797.96 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2179.62 kN.
-. phiVsz = phi*Vsz = 1961.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2159.75 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5839.12 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2159.75 kN.
-. phiVsy = phi*Vsy = 1943.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 196.558 kN.
-. Vr = 3122.206 kN.
-. Ratio = Vu / Vr = 0.063 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 218.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 218.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0069 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0069 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0069 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115126,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5119.32       -58.55       -31.31      -157.17       -87.41
           ------------------------------------------------------------------------------
            DL+LL+Others     5119.32       -58.55       -31.31      -157.17       -87.41
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       31.31 kN-m.
           -. End Moments (My2) =       58.55 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -31.31 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -31.31 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       87.41 kN-m.
          -. End Moments (Mz2) =      157.17 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -87.41 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -87.41 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       149.147 kN-m.
          -. Mrz        =       416.727 kN-m.
          -. Mr         =       442.613 kN-m.
          -. Pu/Pr      =   0.210  --->  O.K !
          -. Muy/Mry    =   0.210  --->  O.K !
          -. Muz/Mrz    =   0.210  --->  O.K !
          -. Mu/Mr      =   0.210  --->  O.K !
          -. Ratio      =   0.210  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5102.66 kN.
          -. Vuz    =         54.55 kN.
          -. Muy    =        -58.55 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.05

          -. Vuy    =        139.52 kN.
          -. Muz    =       -157.17 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96
```

( ). Compute shear strength of concrete.
-. Vuz = 54.55 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1376.44 kN.
-. phiVcz = phi * Vcz = 1238.79 kN.

-. Vuy = 139.52 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1335.78 kN.
-. phiVcy = phi * Vcy = 1202.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2191.65 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5772.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2191.65 kN.
-. phiVsz = phi*Vsz = 1972.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2172.61 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5812.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2172.61 kN.
-. phiVsy = phi*Vsy = 1955.35 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 149.808 kN.
-. Vr = 3157.553 kN.
-. Ratio = Vu / Vr = 0.047 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 166.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 166.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0074 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0074 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0074 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115127,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5135.99       -31.31       -13.15       -87.41       -38.36
           ------------------------------------------------------------------------------
            DL+LL+Others     5135.99       -31.31       -13.15       -87.41       -38.36
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.15 kN-m.
           -. End Moments (My2) =       31.31 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       38.36 kN-m.
          -. End Moments (Mz2) =       87.41 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -38.36 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -38.36 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        62.475 kN-m.
          -. Mrz        =       182.274 kN-m.
          -. Mr         =       192.684 kN-m.
          -. Pu/Pr      =   0.210  --->  O.K !
          -. Muy/Mry    =   0.211  --->  O.K !
          -. Muz/Mrz    =   0.210  --->  O.K !
          -. Mu/Mr      =   0.211  --->  O.K !
          -. Ratio      =   0.211  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5135.99 kN.
          -. Vuz    =         36.35 kN.
          -. Muy    =        -13.15 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.09

          -. Vuy    =         98.10 kN.
          -. Muz    =        -38.36 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.79 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.00
```

( ). Compute shear strength of concrete.
-. Vuz = 36.35 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1397.24 kN.
-. phiVcz = phi * Vcz = 1257.52 kN.

-. Vuy = 98.10 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1357.02 kN.
-. phiVcy = phi * Vcy = 1221.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2201.05 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5751.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2201.05 kN.
-. phiVsz = phi*Vsz = 1980.94 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2182.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5791.46 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2182.67 kN.
-. phiVsy = phi*Vsy = 1964.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 104.617 kN.
-. Vr = 3185.723 kN.
-. Ratio = Vu / Vr = 0.033 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 116.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 116.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0079 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0079 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0079 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115128,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5152.66       -13.15        -3.05       -38.36        -9.43
           ------------------------------------------------------------------------------
            DL+LL+Others     5152.66       -13.15        -3.05       -38.36        -9.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.05 kN-m.
           -. End Moments (My2) =       13.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.05 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.05 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        9.43 kN-m.
          -. End Moments (Mz2) =       38.36 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -9.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -9.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        14.469 kN-m.
          -. Mrz        =        44.682 kN-m.
          -. Mr         =        46.966 kN-m.
          -. Pu/Pr      =   0.211  --->  O.K !
          -. Muy/Mry    =   0.211  --->  O.K !
          -. Muz/Mrz    =   0.211  --->  O.K !
          -. Mu/Mr      =   0.211  --->  O.K !
          -. Ratio      =   0.211  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5152.66 kN.
          -. Vuz    =         20.22 kN.
          -. Muy    =         -3.05 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.12

          -. Vuy    =         57.85 kN.
          -. Muz    =         -9.43 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.71 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.04
```

( ). Compute shear strength of concrete.
-. Vuz = 20.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1411.41 kN.
-. phiVcz = phi * Vcz = 1270.27 kN.

-. Vuy = 57.85 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1371.50 kN.
-. phiVcy = phi * Vcy = 1234.35 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2207.32 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5737.08 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2207.32 kN.
-. phiVsz = phi*Vsz = 1986.58 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2189.38 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5776.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2189.38 kN.
-. phiVsy = phi*Vsy = 1970.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 61.278 kN.
-. Vr = 3204.796 kN.
-. Ratio = Vu / Vr = 0.019 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 68.09 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 68.09 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0081 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0081 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0081 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115129,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5169.32        -3.05         0.00        -9.43         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5169.32        -3.05         0.00        -9.43         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        3.05 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        9.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.212  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.212  --->  O.K !
          -. Ratio      =   0.212  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5169.32 kN.
          -. Vuz    =          6.11 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.07

          -. Vuy    =         18.87 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.07
```

( ). Compute shear strength of concrete.
-. Vuz = 6.11 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1385.57 kN.
-. phiVcz = phi * Vcz = 1247.01 kN.

-. Vuy = 18.87 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1385.57 kN.
-. phiVcy = phi * Vcy = 1247.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2195.80 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5762.92 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2195.80 kN.
-. phiVsz = phi*Vsz = 1976.22 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2195.80 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5762.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2195.80 kN.
-. phiVsy = phi*Vsy = 1976.22 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 19.832 kN.
-. Vr = 3223.232 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 22.04 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 22.04 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0083 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0083 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0083 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115202,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -833.78       766.14      1069.99       514.53       210.61
           ---------------------------------------------------------------------------
           DL+LL+Others     -833.78       766.14      1069.99       514.53       210.61
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3121.059 kN.
          -. Mry        =      4025.348 kN-m.
          -. Mrz        =       792.339 kN-m.
          -. Mr         =      4102.588 kN-m.
          -. Pu/Pr      =   0.267  --->  O.K !
          -. Muy/Mry    =   0.266  --->  O.K !
          -. Muz/Mrz    =   0.266  --->  O.K !
          -. Mu/Mr      =   0.267  --->  O.K !
          -. Ratio      =   0.267  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4693.39 kN.
          -. Vuz    =        494.08 kN.
          -. Muy    =       -663.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.44
```

```
          -. Vuy    =       1154.18 kN.
          -. Muz    =       -387.98 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.88 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.35

     ( ). Compute shear strength of concrete.
          -. Vuz       =      494.08 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1103.28 kN.
          -. phiVcz    = phi * Vcz =      992.95 kN.

          -. Vuy       =     1154.18 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1059.89 kN.
          -. phiVcy    = phi * Vcy =      953.90 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2043.44 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6045.20 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2043.44 kN.
          -. phiVsz   = phi*Vsz =     1839.10 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2014.63 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6088.59 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2014.63 kN.
          -. phiVsy   = phi*Vsy =     1813.17 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1255.486 kN.
          -. Vr       =    2767.073 kN.
          -. Ratio    = Vu / Vr = 0.454  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1394.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1394.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0026 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0026 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115203,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -821.92      1069.99      1360.00       210.61       293.78
           ------------------------------------------------------------------------------
            DL+LL+Others     -821.92      1069.99      1360.00       210.61       293.78
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2529.628 kN.
          -. Mry        =      4179.463 kN-m.
          -. Mrz        =       910.492 kN-m.
          -. Mr         =      4277.488 kN-m.
          -. Pu/Pr      =   0.325  --->  O.K !
          -. Muy/Mry    =   0.325  --->  O.K !
          -. Muz/Mrz    =   0.323  --->  O.K !
          -. Mu/Mr      =   0.325  --->  O.K !
          -. Ratio      =   0.325  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4710.23 kN.
          -. Vuz    =        464.32 kN.
          -. Muy    =       -874.98 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.46
```

-. Vuy = 1102.17 kN.
-. Muz = -601.49 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.80 Deg. [Clause 5.8.3.4.2]
-. betay = 2.37

( ). Compute shear strength of concrete.
-. Vuz = 464.32 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1112.02 kN.
-. phiVcz = phi * Vcz = 1000.81 kN.

-. Vuy = 1102.17 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1068.63 kN.
-. phiVcy = phi * Vcy = 961.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2049.03 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6036.47 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2049.03 kN.
-. phiVsz = phi*Vsz = 1844.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2020.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6079.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2020.57 kN.
-. phiVsy = phi*Vsy = 1818.52 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1195.979 kN.
-. Vr = 2780.281 kN.
-. Ratio = Vu / Vr = 0.430 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1328.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1328.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115204,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -810.05      1360.00      1617.51       293.78       579.88
           ---------------------------------------------------------------------------
           DL+LL+Others     -810.05      1360.00      1617.51       293.78       579.88
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2080.724 kN.
          -. Mry        =      4139.117 kN-m.
          -. Mrz        =      1479.163 kN-m.
          -. Mr         =      4395.476 kN-m.
          -. Pu/Pr      =   0.389  --->  O.K !
          -. Muy/Mry    =   0.391  --->  O.K !
          -. Muz/Mrz    =   0.392  --->  O.K !
          -. Mu/Mr      =   0.392  --->  O.K !
          -. Ratio      =   0.392  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4727.06 kN.
          -. Vuz    =        413.25 kN.
          -. Muy    =      -1067.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.37
```

-. Vuy = 1011.13 kN.
-. Muz = -1039.12 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.21 Deg. [Clause 5.8.3.4.2]
-. betay = 2.27

( ). Compute shear strength of concrete.
-. Vuz = 413.25 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1068.48 kN.
-. phiVcz = phi * Vcz = 961.63 kN.

-. Vuy = 1011.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1025.14 kN.
-. phiVcy = phi * Vcy = 922.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2020.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6080.01 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2020.47 kN.
-. phiVsz = phi*Vsz = 1818.42 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1990.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6123.35 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1990.24 kN.
-. phiVsy = phi*Vsy = 1791.22 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1092.318 kN.
-. Vr = 2713.845 kN.
-. Ratio = Vu / Vr = 0.402 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1213.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1213.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115205,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -798.19      1617.51      1848.26       579.88       875.38
           ---------------------------------------------------------------------------
           DL+LL+Others     -798.19      1617.51      1848.26       579.88       875.38
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1741.134 kN.
          -. Mry        =      4058.197 kN-m.
          -. Mrz        =      1923.736 kN-m.
          -. Mr         =      4491.072 kN-m.
          -. Pu/Pr      =   0.458  --->  O.K !
          -. Muy/Mry    =   0.455  --->  O.K !
          -. Muz/Mrz    =   0.455  --->  O.K !
          -. Mu/Mr      =   0.458  --->  O.K !
          -. Ratio      =   0.458  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4743.89 kN.
          -. Vuz    =        364.13 kN.
          -. Muy    =      -1243.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =       921.73 kN.
          -. Muz    =     -1449.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.60 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.18

     ( ). Compute shear strength of concrete.
          -. Vuz       =     364.13 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1028.87 kN.
          -. phiVcz    = phi * Vcz =      925.98 kN.

          -. Vuy       =     921.73 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      985.70 kN.
          -. phiVcy    = phi * Vcy =      887.13 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1992.92 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6119.62 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1992.92 kN.
          -. phiVsz   = phi*Vsz =     1793.63 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1961.03 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6162.79 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1961.03 kN.
          -. phiVsy   = phi*Vsy =     1764.92 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     991.053 kN.
          -. Vr       =    2652.052 kN.
          -. Ratio    = Vu / Vr = 0.374  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1101.17 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1101.17 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115206,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1562.00      1258.51      1391.88      1296.88      1661.63
           ---------------------------------------------------------------------------
           DL+LL+Others    -1562.00      1258.51      1391.88      1296.88      1661.63
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2997.985 kN.
          -. Mry        =      2661.646 kN-m.
          -. Mrz        =      3173.247 kN-m.
          -. Mr         =      4141.721 kN-m.
          -. Pu/Pr      =   0.521  --->  O.K !
          -. Muy/Mry    =   0.523  --->  O.K !
          -. Muz/Mrz    =   0.524  --->  O.K !
          -. Mu/Mr      =   0.524  --->  O.K !
          -. Ratio      =   0.524  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4760.70 kN.
          -. Vuz    =        279.03 kN.
          -. Muy    =      -1384.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.23
```

-. Vuy = 763.40 kN.
-. Muz = -1786.21 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.84 Deg. [Clause 5.8.3.4.2]
-. betay = 2.13

( ). Compute shear strength of concrete.
-. Vuz = 279.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1006.48 kN.
-. phiVcz = phi * Vcz = 905.83 kN.

-. Vuy = 763.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 963.45 kN.
-. phiVcy = phi * Vcy = 867.11 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1976.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6142.01 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1976.63 kN.
-. phiVsz = phi*Vsz = 1778.97 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1943.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6185.03 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1943.77 kN.
-. phiVsy = phi*Vsy = 1749.40 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 812.799 kN.
-. Vr = 2616.506 kN.
-. Ratio = Vu / Vr = 0.311 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 903.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 903.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115207,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1550.17      1391.88      1481.86      1661.63      1943.25
           ---------------------------------------------------------------------------
           DL+LL+Others    -1550.17      1391.88      1481.86      1661.63      1943.25
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2665.808 kN.
          -. Mry        =      2557.966 kN-m.
          -. Mrz        =      3375.873 kN-m.
          -. Mr         =      4235.529 kN-m.
          -. Pu/Pr      =   0.581  --->  O.K !
          -. Muy/Mry    =   0.579  --->  O.K !
          -. Muz/Mrz    =   0.576  --->  O.K !
          -. Mu/Mr      =   0.581  --->  O.K !
          -. Ratio      =   0.581  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4777.52 kN.
          -. Vuz    =        188.63 kN.
          -. Muy    =      -1481.07 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
```

```
          -. Vuy    =       590.92 kN.
          -. Muz    =     -2042.23 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.11

     ( ). Compute shear strength of concrete.
          -. Vuz       =     188.63 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     995.44 kN.
          -. phiVcz    = phi * Vcz =     895.90 kN.

          -. Vuy       =     590.92 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     952.51 kN.
          -. phiVcy    = phi * Vcy =     857.25 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1968.41 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6153.04 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1968.41 kN.
          -. phiVsz   = phi*Vsz =     1771.57 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1935.06 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6195.98 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1935.06 kN.
          -. phiVsy   = phi*Vsy =     1741.56 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     620.295 kN.
          -. Vr       =    2598.812 kN.
          -. Ratio    = Vu / Vr = 0.239  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 689.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 689.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115208,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1538.32      1481.86      1529.12      1943.25      2140.65
           ---------------------------------------------------------------------------
           DL+LL+Others    -1538.32      1481.86      1529.12      1943.25      2140.65
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2501.817 kN.
          -. Mry        =      2482.780 kN-m.
          -. Mrz        =      3494.641 kN-m.
          -. Mr         =      4286.807 kN-m.
          -. Pu/Pr      =   0.615  --->  O.K !
          -. Muy/Mry    =   0.616  --->  O.K !
          -. Muz/Mrz    =   0.613  --->  O.K !
          -. Mu/Mr      =   0.616  --->  O.K !
          -. Ratio      =   0.616  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4794.32 kN.
          -. Vuz    =        101.65 kN.
          -. Muy    =      -1533.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
```

```
          -. Vuy    =       418.86 kN.
          -. Muz    =     -2216.40 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.98 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.10

     ( ). Compute shear strength of concrete.
          -. Vuz       =      101.65 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      993.72 kN.
          -. phiVcz    = phi * Vcz =      894.35 kN.

          -. Vuy       =      418.86 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      950.80 kN.
          -. phiVcy    = phi * Vcy =      855.72 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1967.11 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6154.76 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1967.11 kN.
          -. phiVsz   = phi*Vsz =     1770.40 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1933.69 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6197.69 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1933.69 kN.
          -. phiVsy   = phi*Vsy =     1740.32 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     431.020 kN.
          -. Vr       =    2596.041 kN.
          -. Ratio    = Vu / Vr = 0.166  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 478.91 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 478.91 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115209,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1526.48      1529.12      1535.25      2140.65      2256.18
           ---------------------------------------------------------------------------
           DL+LL+Others    -1526.48      1529.12      1535.25      2140.65      2256.18
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2427.196 kN.
          -. Mry        =      2417.278 kN-m.
          -. Mrz        =      3565.275 kN-m.
          -. Mr         =      4307.484 kN-m.
          -. Pu/Pr      =   0.629  --->  O.K !
          -. Muy/Mry    =   0.635  --->  O.K !
          -. Muz/Mrz    =   0.633  --->  O.K !
          -. Mu/Mr      =   0.635  --->  O.K !
          -. Ratio      =   0.635  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4811.12 kN.
          -. Vuz    =         32.73 kN.
          -. Muy    =      -1544.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.45 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.21
```

-. Vuy = 253.16 kN.
-. Muz = -2311.33 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.91 Deg. [Clause 5.8.3.4.2]
-. betay = 2.12

( ). Compute shear strength of concrete.
-. Vuz = 32.73 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1000.06 kN.
-. phiVcz = phi * Vcz = 900.06 kN.

-. Vuy = 253.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 957.09 kN.
-. phiVcy = phi * Vcy = 861.38 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1971.87 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6148.42 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1971.87 kN.
-. phiVsz = phi*Vsz = 1774.68 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1938.73 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6191.40 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1938.73 kN.
-. phiVsy = phi*Vsy = 1744.85 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 255.262 kN.
-. Vr = 2606.233 kN.
-. Ratio = Vu / Vr = 0.098 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 283.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 283.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115210,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1514.62      1535.25      1503.77      2256.18      2295.28
           ---------------------------------------------------------------------------
           DL+LL+Others    -1514.62      1535.25      1503.77      2256.18      2295.28
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2390.481 kN.
          -. Mry        =      2363.317 kN-m.
          -. Mrz        =      3613.508 kN-m.
          -. Mr         =      4317.720 kN-m.
          -. Pu/Pr      =   0.634  --->  O.K !
          -. Muy/Mry    =   0.636  --->  O.K !
          -. Muz/Mrz    =   0.635  --->  O.K !
          -. Mu/Mr      =   0.636  --->  O.K !
          -. Ratio      =   0.636  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4035.41 kN.
          -. Vuz    =        109.14 kN.
          -. Muy    =      -2210.10 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.33
```

```
          -. Vuy    =         91.20 kN.
          -. Muz    =      -1602.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.35 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.24

     ( ). Compute shear strength of concrete.
          -. Vuz       =      109.14 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1054.07 kN.
          -. phiVcz    = phi * Vcz =      948.66 kN.

          -. Vuy       =       91.20 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1010.78 kN.
          -. phiVcy    = phi * Vcy =      909.70 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2010.63 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6094.41 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2010.63 kN.
          -. phiVsz   = phi*Vsz =     1809.57 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1979.81 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6137.70 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1979.81 kN.
          -. phiVsy   = phi*Vsy =     1781.82 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     142.229 kN.
          -. Vr       =    2691.529 kN.
          -. Ratio    = Vu / Vr = 0.053  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 158.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 158.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115211,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1514.75      1503.77      1441.21      2295.28      2268.87
           ---------------------------------------------------------------------------
           DL+LL+Others    -1514.75      1503.77      1441.21      2295.28      2268.87
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2390.481 kN.
          -. Mry        =      2363.317 kN-m.
          -. Mrz        =      3613.508 kN-m.
          -. Mr         =      4317.720 kN-m.
          -. Pu/Pr      =   0.634  --->  O.K !
          -. Muy/Mry    =   0.636  --->  O.K !
          -. Muz/Mrz    =   0.635  --->  O.K !
          -. Mu/Mr      =   0.636  --->  O.K !
          -. Ratio      =   0.636  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4052.16 kN.
          -. Vuz    =        191.50 kN.
          -. Muy    =      -2160.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.33
```

-. Vuy = 73.82 kN.
-. Muz = -1614.75 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.38 Deg. [Clause 5.8.3.4.2]
-. betay = 2.23

( ). Compute shear strength of concrete.
-. Vuz = 191.50 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1050.61 kN.
-. phiVcz = phi * Vcz = 945.55 kN.

-. Vuy = 73.82 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1007.34 kN.
-. phiVcy = phi * Vcy = 906.60 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2008.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6097.87 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2008.24 kN.
-. phiVsz = phi*Vsz = 1807.41 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1977.27 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6141.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1977.27 kN.
-. phiVsy = phi*Vsy = 1779.54 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 205.240 kN.
-. Vr = 2686.145 kN.
-. Ratio = Vu / Vr = 0.076 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 228.04 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 228.04 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115212,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1502.88      1441.21      1354.92      2268.87      2190.28
           ---------------------------------------------------------------------------
           DL+LL+Others    -1502.88      1441.21      1354.92      2268.87      2190.28
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2422.919 kN.
          -. Mry        =      2309.757 kN-m.
          -. Mrz        =      3636.405 kN-m.
          -. Mr         =      4307.949 kN-m.
          -. Pu/Pr      =   0.620  --->  O.K !
          -. Muy/Mry    =   0.624  --->  O.K !
          -. Muz/Mrz    =   0.624  --->  O.K !
          -. Mu/Mr      =   0.624  --->  O.K !
          -. Ratio      =   0.624  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4068.91 kN.
          -. Vuz    =        254.59 kN.
          -. Muy    =      -2067.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.95 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.33
```

```
          -. Vuy    =       132.38 kN.
          -. Muz    =     -1584.52 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.36 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.23

     ( ). Compute shear strength of concrete.
          -. Vuz       =     254.59 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1052.34 kN.
          -. phiVcz    = phi * Vcz =      947.11 kN.

          -. Vuy       =     132.38 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1009.06 kN.
          -. phiVcy    = phi * Vcy =      908.15 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2009.43 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6096.15 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2009.43 kN.
          -. phiVsz   = phi*Vsz =     1808.49 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1978.54 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6139.43 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1978.54 kN.
          -. phiVsy   = phi*Vsy =     1780.68 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     286.951 kN.
          -. Vr       =    2688.835 kN.
          -. Ratio    = Vu / Vr = 0.107  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 318.83 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 318.83 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115213,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1491.00      1354.92      1251.05      2190.28      2071.09
           ---------------------------------------------------------------------------
           DL+LL+Others    -1491.00      1354.92      1251.05      2190.28      2071.09
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2490.325 kN.
          -. Mry        =      2257.862 kN-m.
          -. Mrz        =      3645.484 kN-m.
          -. Mr         =      4288.064 kN-m.
          -. Pu/Pr      =   0.599  --->  O.K !
          -. Muy/Mry    =   0.600  --->  O.K !
          -. Muz/Mrz    =   0.601  --->  O.K !
          -. Mu/Mr      =   0.601  --->  O.K !
          -. Ratio      =   0.601  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4085.65 kN.
          -. Vuz    =        302.93 kN.
          -. Muy    =      -1941.01 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

-. Vuy = 182.94 kN.
-. Muz = -1520.39 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.28 Deg. [Clause 5.8.3.4.2]
-. betay = 2.25

( ). Compute shear strength of concrete.
-. Vuz = 302.93 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1061.14 kN.
-. phiVcz = phi * Vcz = 955.03 kN.

-. Vuy = 182.94 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1017.82 kN.
-. phiVcy = phi * Vcy = 916.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2015.48 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6087.35 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2015.48 kN.
-. phiVsz = phi*Vsz = 1813.94 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1984.95 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6130.66 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1984.95 kN.
-. phiVsy = phi*Vsy = 1786.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 353.883 kN.
-. Vr = 2702.500 kN.
-. Ratio = Vu / Vr = 0.131 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 393.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 393.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115214,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1479.12      1251.05      1135.13      2071.09      1923.62
           ---------------------------------------------------------------------------
           DL+LL+Others    -1479.12      1251.05      1135.13      2071.09      1923.62
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2592.707 kN.
          -. Mry        =      2204.796 kN-m.
          -. Mrz        =      3642.653 kN-m.
          -. Mr         =      4257.939 kN-m.
          -. Pu/Pr      =   0.570  --->  O.K !
          -. Muy/Mry    =   0.567  --->  O.K !
          -. Muz/Mrz    =   0.569  --->  O.K !
          -. Mu/Mr      =   0.570  --->  O.K !
          -. Ratio      =   0.570  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4878.36 kN.
          -. Vuz    =        231.94 kN.
          -. Muy    =      -1268.22 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.26
```

```
          -. Vuy    =       316.67 kN.
          -. Muz    =     -2070.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.67 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.17

     ( ). Compute shear strength of concrete.
          -. Vuz       =     231.94 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1022.19 kN.
          -. phiVcz    = phi * Vcz =      919.97 kN.

          -. Vuy       =     316.67 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      979.06 kN.
          -. phiVcy    = phi * Vcy =      881.15 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1988.12 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6126.30 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1988.12 kN.
          -. phiVsz   = phi*Vsz =     1789.31 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1955.94 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6169.43 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1955.94 kN.
          -. phiVsy   = phi*Vsy =     1760.34 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     392.527 kN.
          -. Vr       =    2641.497 kN.
          -. Ratio    = Vu / Vr = 0.149  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 436.14 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 436.14 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115215,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1467.23      1135.13      1012.40      1923.62      1756.30
           ---------------------------------------------------------------------------
           DL+LL+Others    -1467.23      1135.13      1012.40      1923.62      1756.30
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2764.928 kN.
          -. Mry        =      2141.368 kN-m.
          -. Mrz        =      3621.376 kN-m.
          -. Mr         =      4207.116 kN-m.
          -. Pu/Pr      =   0.531  --->  O.K !
          -. Muy/Mry    =   0.530  --->  O.K !
          -. Muz/Mrz    =   0.531  --->  O.K !
          -. Mu/Mr      =   0.531  --->  O.K !
          -. Ratio      =   0.531  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4895.12 kN.
          -. Vuz    =        246.32 kN.
          -. Muy    =      -1152.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.07 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.30
```

-. Vuy = 352.38 kN.
-. Muz = -1915.12 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.49 Deg. [Clause 5.8.3.4.2]
-. betay = 2.21

( ). Compute shear strength of concrete.
-. Vuz = 246.32 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1039.50 kN.
-. phiVcz = phi * Vcz = 935.55 kN.

-. Vuy = 352.38 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 996.27 kN.
-. phiVcy = phi * Vcy = 896.64 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2000.47 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6108.99 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2000.47 kN.
-. phiVsz = phi*Vsz = 1800.42 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1969.03 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6152.22 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1969.03 kN.
-. phiVsy = phi*Vsy = 1772.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 429.937 kN.
-. Vr = 2668.768 kN.
-. Ratio = Vu / Vr = 0.161 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 477.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 477.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-8.6588e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-8.6588e-005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115216,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1455.33      1012.40       886.15      1756.30      1575.64
           ---------------------------------------------------------------------------
           DL+LL+Others    -1455.33      1012.40       886.15      1756.30      1575.64
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2974.975 kN.
          -. Mry        =      2071.812 kN-m.
          -. Mrz        =      3590.095 kN-m.
          -. Mr         =      4145.019 kN-m.
          -. Pu/Pr      =   0.489  --->  O.K !
          -. Muy/Mry    =   0.489  --->  O.K !
          -. Muz/Mrz    =   0.489  --->  O.K !
          -. Mu/Mr      =   0.489  --->  O.K !
          -. Ratio      =   0.489  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4911.87 kN.
          -. Vuz    =        253.99 kN.
          -. Muy    =      -1029.40 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

```
          -. Vuy    =       375.27 kN.
          -. Muz    =     -1741.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.28 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.25

     ( ). Compute shear strength of concrete.
          -. Vuz       =     253.99 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1061.15 kN.
          -. phiVcz    = phi * Vcz =      955.04 kN.

          -. Vuy       =     375.27 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1017.84 kN.
          -. phiVcy    = phi * Vcy =      916.05 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2015.49 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6087.34 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2015.49 kN.
          -. phiVsz   = phi*Vsz =     1813.94 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1984.96 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6130.65 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1984.96 kN.
          -. phiVsy   = phi*Vsy =     1786.47 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     453.140 kN.
          -. Vr       =    2702.519 kN.
          -. Ratio    = Vu / Vr = 0.168  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 503.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 503.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115217,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1443.43       886.15       759.01      1575.64      1387.19
           ---------------------------------------------------------------------------
           DL+LL+Others    -1443.43       886.15       759.01      1575.64      1387.19
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3260.420 kN.
          -. Mry        =      1988.124 kN-m.
          -. Mrz        =      3540.300 kN-m.
          -. Mr         =      4060.340 kN-m.
          -. Pu/Pr      =   0.443  --->  O.K !
          -. Muy/Mry    =   0.446  --->  O.K !
          -. Muz/Mrz    =   0.445  --->  O.K !
          -. Mu/Mr      =   0.446  --->  O.K !
          -. Ratio      =   0.446  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4928.61 kN.
          -. Vuz    =        256.29 kN.
          -. Muy    =       -902.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.40
```

```
          -. Vuy    =       387.74 kN.
          -. Muz    =     -1555.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.31

     ( ). Compute shear strength of concrete.
          -. Vuz       =     256.29 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1086.49 kN.
          -. phiVcz    = phi * Vcz =      977.84 kN.

          -. Vuy       =     387.74 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1043.11 kN.
          -. phiVcy    = phi * Vcy =      938.80 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2032.50 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6062.00 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2032.50 kN.
          -. phiVsz   = phi*Vsz =     1829.25 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2003.01 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6105.37 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2003.01 kN.
          -. phiVsy   = phi*Vsy =     1802.71 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     464.787 kN.
          -. Vr       =    2741.512 kN.
          -. Ratio    = Vu / Vr = 0.170  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 516.43 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 516.43 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115218,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1431.52       759.01       633.32      1387.19      1194.46
           ---------------------------------------------------------------------------
           DL+LL+Others    -1431.52       759.01       633.32      1387.19      1194.46
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3589.706 kN.
          -. Mry        =      1892.850 kN-m.
          -. Mrz        =      3481.242 kN-m.
          -. Mr         =      3962.565 kN-m.
          -. Pu/Pr      =   0.399  --->  O.K !
          -. Muy/Mry    =   0.401  --->  O.K !
          -. Muz/Mrz    =   0.398  --->  O.K !
          -. Mu/Mr      =   0.401  --->  O.K !
          -. Ratio      =   0.401  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4945.35 kN.
          -. Vuz    =        253.88 kN.
          -. Muy    =       -774.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.41 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47
```

```
          -. Vuy    =        393.43 kN.
          -. Muz    =      -1363.03 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.37

     ( ). Compute shear strength of concrete.
          -. Vuz       =      253.88 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1114.81 kN.
          -. phiVcz    = phi * Vcz =     1003.33 kN.

          -. Vuy       =      393.43 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1071.43 kN.
          -. phiVcy    = phi * Vcy =      964.29 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2050.81 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6033.67 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2050.81 kN.
          -. phiVsz   = phi*Vsz =     1845.73 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2022.46 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6077.06 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2022.46 kN.
          -. phiVsy   = phi*Vsy =     1820.22 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     468.231 kN.
          -. Vr       =    2784.503 kN.
          -. Ratio    = Vu / Vr = 0.168  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 520.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 520.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115219,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1419.60       633.32       515.35      1194.46      1001.84
           ---------------------------------------------------------------------------
           DL+LL+Others    -1419.60       633.32       515.35      1194.46      1001.84
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4021.905 kN.
          -. Mry        =      1786.968 kN-m.
          -. Mrz        =      3389.599 kN-m.
          -. Mr         =      3831.793 kN-m.
          -. Pu/Pr      =   0.353  --->  O.K !
          -. Muy/Mry    =   0.354  --->  O.K !
          -. Muz/Mrz    =   0.352  --->  O.K !
          -. Mu/Mr      =   0.354  --->  O.K !
          -. Ratio      =   0.354  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4962.08 kN.
          -. Vuz    =        239.12 kN.
          -. Muy    =       -647.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.16 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.54
```

```
          -. Vuy    =       386.82 kN.
          -. Muz    =     -1167.58 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.44

     ( ). Compute shear strength of concrete.
          -. Vuz       =     239.12 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1146.95 kN.
          -. phiVcz    = phi * Vcz =     1032.26 kN.

          -. Vuy       =     386.82 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1103.63 kN.
          -. phiVcy    = phi * Vcy =      993.26 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2070.76 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6001.53 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2070.76 kN.
          -. phiVsz   = phi*Vsz =     1863.68 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2043.66 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6044.86 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2043.66 kN.
          -. phiVsy   = phi*Vsy =     1839.30 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     454.765 kN.
          -. Vr       =    2832.562 kN.
          -. Ratio    = Vu / Vr = 0.161  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 505.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 505.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115220,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1407.68       515.35       408.08      1001.84       817.31
           ---------------------------------------------------------------------------
           DL+LL+Others    -1407.68       515.35       408.08      1001.84       817.31
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4544.981 kN.
          -. Mry        =      1674.076 kN-m.
          -. Mrz        =      3254.616 kN-m.
          -. Mr         =      3659.926 kN-m.
          -. Pu/Pr      =   0.310  --->  O.K !
          -. Muy/Mry    =   0.308  --->  O.K !
          -. Muz/Mrz    =   0.308  --->  O.K !
          -. Mu/Mr      =   0.310  --->  O.K !
          -. Ratio      =   0.310  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4978.81 kN.
          -. Vuz    =        218.15 kN.
          -. Muy    =       -528.16 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62
```

```
          -. Vuy    =        366.67 kN.
          -. Muz    =       -974.54 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.22 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.52

     ( ). Compute shear strength of concrete.
          -. Vuz       =      218.15 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1182.01 kN.
          -. phiVcz    = phi * Vcz =     1063.81 kN.

          -. Vuy       =      366.67 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1138.84 kN.
          -. phiVcy    = phi * Vcy =     1024.96 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2091.56 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5966.47 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2091.56 kN.
          -. phiVsz   = phi*Vsz =     1882.40 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2065.80 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6009.65 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2065.80 kN.
          -. phiVsy   = phi*Vsy =     1859.22 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     426.658 kN.
          -. Vr       =    2884.177 kN.
          -. Ratio    = Vu / Vr = 0.148  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 474.06 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 474.06 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115221,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1395.75       408.08       313.27       817.31       646.54
           ---------------------------------------------------------------------------
           DL+LL+Others    -1395.75       408.08       313.27       817.31       646.54
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5226.923 kN.
          -. Mry        =      1539.362 kN-m.
          -. Mrz        =      3069.908 kN-m.
          -. Mr         =      3434.235 kN-m.
          -. Pu/Pr      =   0.267  --->  O.K !
          -. Muy/Mry    =   0.265  --->  O.K !
          -. Muz/Mrz    =   0.266  --->  O.K !
          -. Mu/Mr      =   0.267  --->  O.K !
          -. Ratio      =   0.267  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4995.52 kN.
          -. Vuz    =        193.37 kN.
          -. Muy    =       -419.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70
```

```
          -. Vuy    =       336.54 kN.
          -. Muz    =      -791.33 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.60

     ( ). Compute shear strength of concrete.
          -. Vuz       =     193.37 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1218.54 kN.
          -. phiVcz    = phi * Vcz =     1096.69 kN.

          -. Vuy       =     336.54 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1175.62 kN.
          -. phiVcy    = phi * Vcy =     1058.06 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2112.25 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5929.95 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2112.25 kN.
          -. phiVsz   = phi*Vsz =     1901.02 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2087.84 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5972.86 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2087.84 kN.
          -. phiVsy   = phi*Vsy =     1879.05 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     388.132 kN.
          -. Vr       =    2937.113 kN.
          -. Ratio    = Vu / Vr = 0.132  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 431.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 431.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115222,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5012.23      -322.50      -239.19      -623.12      -473.24
           ------------------------------------------------------------------------------
            DL+LL+Others     5012.23      -322.50      -239.19      -623.12      -473.24
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      239.19 kN-m.
           -. End Moments (My2) =      322.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -322.50 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -322.50 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      473.24 kN-m.
          -. End Moments (Mz2) =      623.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -623.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -623.12 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     21649.613 kN.
          -. Mry        =      1382.985 kN-m.
          -. Mrz        =      2668.905 kN-m.
          -. Mr         =      3005.944 kN-m.
          -. Pu/Pr      =   0.232  --->  O.K !
          -. Muy/Mry    =   0.233  --->  O.K !
          -. Muz/Mrz    =   0.233  --->  O.K !
          -. Mu/Mr      =   0.233  --->  O.K !
          -. Ratio      =   0.233  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5012.23 kN.
          -. Vuz    =        166.68 kN.
          -. Muy    =       -322.50 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        299.80 kN.
          -. Muz    =       -623.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.68 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.68
```

( ). Compute shear strength of concrete.
-. Vuz = 166.68 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1255.15 kN.
-. phiVcz = phi * Vcz = 1129.63 kN.

-. Vuy = 299.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1212.58 kN.
-. phiVcy = phi * Vcy = 1091.33 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2132.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5893.34 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2132.04 kN.
-. phiVsz = phi*Vsz = 1918.83 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2108.94 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5935.90 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2108.94 kN.
-. phiVsy = phi*Vsy = 1898.04 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 343.019 kN.
-. Vr = 2989.371 kN.
-. Ratio = Vu / Vr = 0.115 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 381.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 381.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0052 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0052 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0052 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115223,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5028.94      -239.19      -169.48      -473.24      -343.73
           ------------------------------------------------------------------------------
            DL+LL+Others     5028.94      -239.19      -169.48      -473.24      -343.73
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      169.48 kN-m.
           -. End Moments (My2) =      239.19 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -239.19 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -239.19 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      343.73 kN-m.
          -. End Moments (Mz2) =      473.24 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -473.24 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -473.24 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     23479.856 kN.
          -. Mry        =      1110.326 kN-m.
          -. Mrz        =      2211.388 kN-m.
          -. Mr         =      2474.482 kN-m.
          -. Pu/Pr      =   0.214  --->  O.K !
          -. Muy/Mry    =   0.215  --->  O.K !
          -. Muz/Mrz    =   0.214  --->  O.K !
          -. Mu/Mr      =   0.215  --->  O.K !
          -. Ratio      =   0.215  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5028.94 kN.
          -. Vuz    =        139.47 kN.
          -. Muy    =       -239.19 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.17 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.86

          -. Vuy    =        259.15 kN.
          -. Muz    =       -473.24 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.44 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.76
```

( ). Compute shear strength of concrete.
-. Vuz = 139.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1290.59 kN.
-. phiVcz = phi * Vcz = 1161.53 kN.

-. Vuy = 259.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1248.47 kN.
-. phiVcy = phi * Vcy = 1123.62 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2150.36 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5857.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2150.36 kN.
-. phiVsz = phi*Vsz = 1935.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2128.50 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5900.02 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2128.50 kN.
-. phiVsy = phi*Vsy = 1915.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 294.297 kN.
-. Vr = 3039.269 kN.
-. Ratio = Vu / Vr = 0.097 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 327.00 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 327.00 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0058 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0058 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0058 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115224,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5062.29      -169.48      -113.06      -343.73      -235.40
           ------------------------------------------------------------------------------
            DL+LL+Others     5062.29      -169.48      -113.06      -343.73      -235.40
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      113.06 kN-m.
           -. End Moments (My2) =      169.48 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -113.06 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -113.06 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      235.40 kN-m.
          -. End Moments (Mz2) =      343.73 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -235.40 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -235.40 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       545.286 kN-m.
          -. Mrz        =      1134.716 kN-m.
          -. Mr         =      1258.935 kN-m.
          -. Pu/Pr      =   0.207  --->  O.K !
          -. Muy/Mry    =   0.207  --->  O.K !
          -. Muz/Mrz    =   0.207  --->  O.K !
          -. Mu/Mr      =   0.207  --->  O.K !
          -. Ratio      =   0.207  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5045.63 kN.
          -. Vuz    =        112.88 kN.
          -. Muy    =       -169.48 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.93

          -. Vuy    =        216.80 kN.
          -. Muz    =       -343.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.84
```

( ). Compute shear strength of concrete.
-. Vuz = 112.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1323.74 kN.
-. phiVcz = phi * Vcz = 1191.36 kN.

-. Vuy = 216.80 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1282.11 kN.
-. phiVcy = phi * Vcy = 1153.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2166.80 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5824.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2166.80 kN.
-. phiVsz = phi*Vsz = 1950.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2146.05 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5866.37 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2146.05 kN.
-. phiVsy = phi*Vsy = 1931.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 244.424 kN.
-. Vr = 3085.350 kN.
-. Ratio = Vu / Vr = 0.079 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 271.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 271.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0064 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0064 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0064 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115225,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5078.98      -113.06       -69.24      -235.40      -148.27
           ------------------------------------------------------------------------------
            DL+LL+Others     5078.98      -113.06       -69.24      -235.40      -148.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       69.24 kN-m.
           -. End Moments (My2) =      113.06 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -69.24 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -69.24 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      148.27 kN-m.
          -. End Moments (Mz2) =      235.40 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -148.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -148.27 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       332.649 kN-m.
          -. Mrz        =       712.491 kN-m.
          -. Mr         =       786.319 kN-m.
          -. Pu/Pr      =   0.208  --->  O.K !
          -. Muy/Mry    =   0.208  --->  O.K !
          -. Muz/Mrz    =   0.208  --->  O.K !
          -. Mu/Mr      =   0.208  --->  O.K !
          -. Ratio      =   0.208  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5062.32 kN.
          -. Vuz    =         87.65 kN.
          -. Muy    =       -113.06 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.81 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00

          -. Vuy    =        174.28 kN.
          -. Muz    =       -235.40 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.91
```

( ). Compute shear strength of concrete.
-. Vuz = 87.65 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1353.68 kN.
-. phiVcz = phi * Vcz = 1218.32 kN.

-. Vuy = 174.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1312.58 kN.
-. phiVcy = phi * Vcy = 1181.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2181.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5794.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2181.11 kN.
-. phiVsz = phi*Vsz = 1963.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2161.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5835.90 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2161.34 kN.
-. phiVsy = phi*Vsy = 1945.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 195.075 kN.
-. Vr = 3126.533 kN.
-. Ratio = Vu / Vr = 0.062 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 216.75 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 216.75 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0069 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0069 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0069 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115226,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5095.66       -69.24       -37.11      -148.27       -81.95
           ------------------------------------------------------------------------------
            DL+LL+Others     5095.66       -69.24       -37.11      -148.27       -81.95
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       37.11 kN-m.
           -. End Moments (My2) =       69.24 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -37.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -37.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       81.95 kN-m.
          -. End Moments (Mz2) =      148.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -81.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -81.95 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       177.589 kN-m.
          -. Mrz        =       392.568 kN-m.
          -. Mr         =       430.869 kN-m.
          -. Pu/Pr      =   0.209  --->  O.K !
          -. Muy/Mry    =   0.209  --->  O.K !
          -. Muz/Mrz    =   0.209  --->  O.K !
          -. Mu/Mr      =   0.209  --->  O.K !
          -. Ratio      =   0.209  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5079.01 kN.
          -. Vuz    =         64.27 kN.
          -. Muy    =        -69.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.67 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.05

          -. Vuy    =        132.65 kN.
          -. Muz    =       -148.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96
```

( ). Compute shear strength of concrete.
-. Vuz = 64.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1379.74 kN.
-. phiVcz = phi * Vcz = 1241.76 kN.

-. Vuy = 132.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1339.14 kN.
-. phiVcy = phi * Vcy = 1205.23 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2193.15 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5768.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2193.15 kN.
-. phiVsz = phi*Vsz = 1973.84 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2174.22 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5809.34 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2174.22 kN.
-. phiVsy = phi*Vsy = 1956.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 147.399 kN.
-. Vr = 3162.031 kN.
-. Ratio = Vu / Vr = 0.047 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 163.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 163.78 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0074 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0074 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0074 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115227,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5112.34       -37.11       -15.62       -81.95       -35.72
           ------------------------------------------------------------------------------
            DL+LL+Others     5112.34       -37.11       -15.62       -81.95       -35.72
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       15.62 kN-m.
           -. End Moments (My2) =       37.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -15.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -15.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       35.72 kN-m.
          -. End Moments (Mz2) =       81.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -35.72 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -35.72 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        74.412 kN-m.
          -. Mrz        =       170.571 kN-m.
          -. Mr         =       186.096 kN-m.
          -. Pu/Pr      =   0.209  --->  O.K !
          -. Muy/Mry    =   0.210  --->  O.K !
          -. Muz/Mrz    =   0.209  --->  O.K !
          -. Mu/Mr      =   0.210  --->  O.K !
          -. Ratio      =   0.210  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5112.34 kN.
          -. Vuz    =         43.00 kN.
          -. Muy    =        -15.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.10

          -. Vuy    =         92.47 kN.
          -. Muz    =        -35.72 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01
```

( ). Compute shear strength of concrete.
-. Vuz = 43.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1400.31 kN.
-. phiVcz = phi * Vcz = 1260.28 kN.

-. Vuy = 92.47 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1360.16 kN.
-. phiVcy = phi * Vcy = 1224.14 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2202.41 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5748.18 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2202.41 kN.
-. phiVsz = phi*Vsz = 1982.17 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2184.13 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5788.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2184.13 kN.
-. phiVsy = phi*Vsy = 1965.72 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 101.980 kN.
-. Vr = 3189.861 kN.
-. Ratio = Vu / Vr = 0.032 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 113.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 113.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0079 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0079 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0079 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115228,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5129.01       -15.62        -3.62       -35.72        -8.71
           ------------------------------------------------------------------------------
            DL+LL+Others     5129.01       -15.62        -3.62       -35.72        -8.71
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        3.62 kN-m.
           -. End Moments (My2) =       15.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -3.62 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -3.62 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.71 kN-m.
          -. End Moments (Mz2) =       35.72 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.71 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.71 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        17.294 kN-m.
          -. Mrz        =        41.401 kN-m.
          -. Mr         =        44.868 kN-m.
          -. Pu/Pr      =   0.210  --->  O.K !
          -. Muy/Mry    =   0.210  --->  O.K !
          -. Muz/Mrz    =   0.210  --->  O.K !
          -. Mu/Mr      =   0.210  --->  O.K !
          -. Ratio      =   0.210  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5129.01 kN.
          -. Vuz    =         23.99 kN.
          -. Muy    =         -3.62 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.13

          -. Vuy    =         54.03 kN.
          -. Muz    =         -8.71 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.04
```

( ). Compute shear strength of concrete.
-. Vuz = 23.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1414.36 kN.
-. phiVcz = phi * Vcz = 1272.93 kN.

-. Vuy = 54.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1374.52 kN.
-. phiVcy = phi * Vcy = 1237.07 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2208.61 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5734.12 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2208.61 kN.
-. phiVsz = phi*Vsz = 1987.75 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2190.77 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5773.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2190.77 kN.
-. phiVsy = phi*Vsy = 1971.69 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 59.113 kN.
-. Vr = 3208.766 kN.
-. Ratio = Vu / Vr = 0.018 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 65.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 65.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0081 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0081 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0081 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =115229,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5145.67        -3.62         0.00        -8.71         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5145.67        -3.62         0.00        -8.71         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        3.62 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        8.71 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.211  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.211  --->  O.K !
          -. Ratio      =   0.211  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5145.67 kN.
          -. Vuz    =          7.25 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.07

          -. Vuy    =         17.41 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.62 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.07
```

( ). Compute shear strength of concrete.
-. Vuz = 7.25 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1388.20 kN.
-. phiVcz = phi * Vcz = 1249.38 kN.

-. Vuy = 17.41 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1388.20 kN.
-. phiVcy = phi * Vcy = 1249.38 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2196.99 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5760.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2196.99 kN.
-. phiVsz = phi*Vsz = 1977.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2196.99 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5760.29 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2196.99 kN.
-. phiVsy = phi*Vsy = 1977.29 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 18.859 kN.
-. Vr = 3226.669 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 20.95 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 20.95 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0083 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0083 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0083 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116002,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1081.55       896.18      1075.33      2152.57      2334.12
           ------------------------------------------------------------------------------
            DL+LL+Others     1081.55       896.18      1075.33      2152.57      2334.12
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      896.18 kN-m.
           -. End Moments (My2) =     1075.33 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1075.33 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1075.33 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2152.57 kN-m.
          -. End Moments (Mz2) =     2334.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2334.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2334.12 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2174.145 kN.
          -. Mry        =      2151.404 kN-m.
          -. Mrz        =      4674.261 kN-m.
          -. Mr         =      5145.606 kN-m.
          -. Pu/Pr      =   0.497  --->  O.K !
          -. Muy/Mry    =   0.500  --->  O.K !
          -. Muz/Mrz    =   0.499  --->  O.K !
          -. Mu/Mr      =   0.500  --->  O.K !
          -. Ratio      =   0.500  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2697.89 kN.
          -. Vuz    =        573.39 kN.
          -. Muy    =      -1591.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.28 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.50

          -. Vuy    =        288.69 kN.
          -. Muz    =      -1620.41 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.64 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.41
```

( ). Compute shear strength of concrete.
-. Vuz = 573.39 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1130.52 kN.
-. phiVcz = phi * Vcz = 1017.47 kN.

-. Vuy = 288.69 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1087.16 kN.
-. phiVcy = phi * Vcy = 978.44 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2060.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6017.96 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2060.67 kN.
-. phiVsz = phi*Vsz = 1854.60 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2032.94 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6061.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2032.94 kN.
-. phiVsy = phi*Vsy = 1829.64 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 641.962 kN.
-. Vr = 2808.086 kN.
-. Ratio = Vu / Vr = 0.229 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 713.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 713.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116003,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1093.53      1075.33      1229.39      2334.12      2460.87
           ---------------------------------------------------------------------------
            DL+LL+Others    1093.53      1075.33      1229.39      2334.12      2460.87
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1075.33 kN-m.
           -. End Moments (My2) =     1229.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1229.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1229.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2334.12 kN-m.
          -. End Moments (Mz2) =     2460.87 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2460.87 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2460.87 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2042.254 kN.
          -. Mry        =      2294.370 kN-m.
          -. Mrz        =      4594.316 kN-m.
          -. Mr         =      5135.355 kN-m.
          -. Pu/Pr      =   0.535  --->  O.K !
          -. Muy/Mry    =   0.536  --->  O.K !
          -. Muz/Mrz    =   0.536  --->  O.K !
          -. Mu/Mr      =   0.536  --->  O.K !
          -. Ratio      =   0.536  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2714.55 kN.
          -. Vuz    =        456.99 kN.
          -. Muy    =      -1808.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47

          -. Vuy    =        209.31 kN.
          -. Muz    =      -1706.29 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 456.99 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1116.86 kN.
-. phiVcz = phi * Vcz = 1005.18 kN.

-. Vuy = 209.31 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1073.48 kN.
-. phiVcy = phi * Vcy = 966.13 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2052.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6031.62 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2052.11 kN.
-. phiVsz = phi*Vsz = 1846.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2023.84 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6075.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2023.84 kN.
-. phiVsy = phi*Vsy = 1821.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 502.648 kN.
-. Vr = 2787.586 kN.
-. Ratio = Vu / Vr = 0.180 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 558.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 558.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116004,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1105.51      1229.39      1346.13      2460.87      2531.00
           ---------------------------------------------------------------------------
            DL+LL+Others     1105.51      1229.39      1346.13      2460.87      2531.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1229.39 kN-m.
           -. End Moments (My2) =     1346.13 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1346.13 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1346.13 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2460.87 kN-m.
          -. End Moments (Mz2) =     2531.00 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2531.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2531.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1959.772 kN.
          -. Mry        =      2407.581 kN-m.
          -. Mrz        =      4526.168 kN-m.
          -. Mr         =      5126.660 kN-m.
          -. Pu/Pr      =   0.564  --->  O.K !
          -. Muy/Mry    =   0.559  --->  O.K !
          -. Muz/Mrz    =   0.559  --->  O.K !
          -. Mu/Mr      =   0.564  --->  O.K !
          -. Ratio      =   0.564  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2731.22 kN.
          -. Vuz    =        330.76 kN.
          -. Muy    =      -1969.29 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.46

          -. Vuy    =        125.00 kN.
          -. Muz    =      -1753.77 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.79 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.37
```

( ). Compute shear strength of concrete.
-. Vuz = 330.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1113.00 kN.
-. phiVcz = phi * Vcz = 1001.70 kN.

-. Vuy = 125.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1069.62 kN.
-. phiVcy = phi * Vcy = 962.65 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2049.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6035.48 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2049.66 kN.
-. phiVsz = phi*Vsz = 1844.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2021.24 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6078.87 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2021.24 kN.
-. phiVsy = phi*Vsy = 1819.12 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 353.595 kN.
-. Vr = 2781.772 kN.
-. Ratio = Vu / Vr = 0.127 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 392.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 392.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116005,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1117.49      1346.13      1418.35      2531.00      2551.30
           ------------------------------------------------------------------------------
            DL+LL+Others     1117.49      1346.13      1418.35      2531.00      2551.30
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1346.13 kN-m.
           -. End Moments (My2) =     1418.35 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1418.35 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1418.35 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2531.00 kN-m.
          -. End Moments (Mz2) =     2551.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2551.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2551.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      1966.794 kN.
          -. Mry        =      2492.542 kN-m.
          -. Mrz        =      4477.686 kN-m.
          -. Mr         =      5124.689 kN-m.
          -. Pu/Pr      =   0.568  --->  O.K !
          -. Muy/Mry    =   0.569  --->  O.K !
          -. Muz/Mrz    =   0.570  --->  O.K !
          -. Mu/Mr      =   0.570  --->  O.K !
          -. Ratio      =   0.570  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2747.88 kN.
          -. Vuz    =        200.78 kN.
          -. Muy    =      -2066.76 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47

          -. Vuy    =         43.76 kN.
          -. Muz    =      -1769.83 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 200.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1117.86 kN.
-. phiVcz = phi * Vcz = 1006.07 kN.

-. Vuy = 43.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1074.47 kN.
-. phiVcy = phi * Vcy = 967.03 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2052.74 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6030.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2052.74 kN.
-. phiVsz = phi*Vsz = 1847.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2024.51 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6074.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2024.51 kN.
-. phiVsy = phi*Vsy = 1822.06 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 205.493 kN.
-. Vr = 2789.085 kN.
-. Ratio = Vu / Vr = 0.074 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 228.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 228.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0044 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0044 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0044 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116006,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1117.49      1418.35      1446.79      2551.30      2515.66
           ------------------------------------------------------------------------------
            DL+LL+Others     1117.49      1418.35      1446.79      2551.30      2515.66
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1418.35 kN-m.
           -. End Moments (My2) =     1446.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1418.35 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1418.35 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2515.66 kN-m.
          -. End Moments (Mz2) =     2551.30 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2551.30 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2551.30 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =      1966.794 kN.
           -. Mry        =      2492.542 kN-m.
           -. Mrz        =      4477.686 kN-m.
           -. Mr         =      5124.689 kN-m.
           -. Pu/Pr      =   0.568  --->  O.K !
           -. Muy/Mry    =   0.569  --->  O.K !
           -. Muz/Mrz    =   0.570  --->  O.K !
           -. Mu/Mr      =   0.570  --->  O.K !
           -. Ratio      =   0.570  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2787.66 kN.
           -. Vuz    =         59.77 kN.
           -. Muy    =      -1378.00 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  33.51 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.44

           -. Vuy    =         94.54 kN.
           -. Muz    =      -2555.98 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  33.89 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.34
```

( ). Compute shear strength of concrete.
-. Vuz = 59.77 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1102.29 kN.
-. phiVcz = phi * Vcz = 992.06 kN.

-. Vuy = 94.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1058.91 kN.
-. phiVcy = phi * Vcy = 953.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2042.80 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6046.19 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2042.80 kN.
-. phiVsz = phi*Vsz = 1838.52 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2013.96 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6089.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2013.96 kN.
-. phiVsy = phi*Vsy = 1812.56 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 111.853 kN.
-. Vr = 2765.575 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 124.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 124.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0048 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116007,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1129.47      1446.79      1439.26      2515.66      2432.38
           ---------------------------------------------------------------------------
            DL+LL+Others     1129.47      1446.79      1439.26      2515.66      2432.38
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1439.26 kN-m.
           -. End Moments (My2) =     1446.79 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1446.79 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1446.79 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2432.38 kN-m.
          -. End Moments (Mz2) =     2515.66 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2515.66 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2515.66 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2000.121 kN.
          -. Mry        =      2552.759 kN-m.
          -. Mrz        =      4450.476 kN-m.
          -. Mr         =      5130.625 kN-m.
          -. Pu/Pr      =   0.565  --->  O.K !
          -. Muy/Mry    =   0.567  --->  O.K !
          -. Muz/Mrz    =   0.565  --->  O.K !
          -. Mu/Mr      =   0.567  --->  O.K !
          -. Ratio      =   0.567  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2804.32 kN.
          -. Vuz    =         32.92 kN.
          -. Muy    =      -1405.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.57 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42

          -. Vuy    =        183.49 kN.
          -. Muz    =      -2521.74 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.95 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.33
```

( ). Compute shear strength of concrete.
-. Vuz = 32.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1095.28 kN.
-. phiVcz = phi * Vcz = 985.75 kN.

-. Vuy = 183.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1051.89 kN.
-. phiVcy = phi * Vcy = 946.70 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2038.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6053.21 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2038.26 kN.
-. phiVsz = phi*Vsz = 1834.43 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2009.12 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6096.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2009.12 kN.
-. phiVsy = phi*Vsy = 1808.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 186.416 kN.
-. Vr = 2754.915 kN.
-. Ratio = Vu / Vr = 0.068 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 207.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 207.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0048 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0048 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116008,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1141.45      1439.26      1402.11      2432.38      2310.98
           ---------------------------------------------------------------------------
            DL+LL+Others    1141.45      1439.26      1402.11      2432.38      2310.98
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1402.11 kN-m.
           -. End Moments (My2) =     1439.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1439.26 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1439.26 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2310.98 kN-m.
          -. End Moments (Mz2) =     2432.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2432.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2432.38 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2073.899 kN.
          -. Mry        =      2611.143 kN-m.
          -. Mrz        =      4420.107 kN-m.
          -. Mr         =      5133.752 kN-m.
          -. Pu/Pr      =   0.550  --->  O.K !
          -. Muy/Mry    =   0.551  --->  O.K !
          -. Muz/Mrz    =   0.550  --->  O.K !
          -. Mu/Mr      =   0.551  --->  O.K !
          -. Ratio      =   0.551  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2820.99 kN.
          -. Vuz    =         81.70 kN.
          -. Muy    =      -1397.97 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.58 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.42

          -. Vuy    =        255.46 kN.
          -. Muz    =      -2439.48 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.33
```

( ). Compute shear strength of concrete.
-. Vuz = 81.70 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1094.95 kN.
-. phiVcz = phi * Vcz = 985.45 kN.

-. Vuy = 255.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1051.56 kN.
-. phiVcy = phi * Vcy = 946.41 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2038.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6053.54 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2038.04 kN.
-. phiVsz = phi*Vsz = 1834.24 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2008.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6096.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2008.90 kN.
-. phiVsy = phi*Vsy = 1808.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 268.205 kN.
-. Vr = 2754.416 kN.
-. Ratio = Vu / Vr = 0.097 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 298.01 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 298.01 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0047 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0047 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116009,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1153.44      1402.11      1341.14      2310.98      2159.94
           ---------------------------------------------------------------------------
            DL+LL+Others     1153.44      1402.11      1341.14      2310.98      2159.94
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1341.14 kN-m.
           -. End Moments (My2) =     1402.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1402.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1402.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     2159.94 kN-m.
          -. End Moments (Mz2) =     2310.98 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2310.98 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2310.98 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2193.031 kN.
          -. Mry        =      2664.629 kN-m.
          -. Mrz        =      4395.348 kN-m.
          -. Mr         =      5139.974 kN-m.
          -. Pu/Pr      =   0.526  --->  O.K !
          -. Muy/Mry    =   0.526  --->  O.K !
          -. Muz/Mrz    =   0.526  --->  O.K !
          -. Mu/Mr      =   0.526  --->  O.K !
          -. Ratio      =   0.526  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2837.65 kN.
          -. Vuz    =        123.49 kN.
          -. Muy    =      -1361.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.44

          -. Vuy    =        311.21 kN.
          -. Muz    =      -2318.77 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.34
```

( ). Compute shear strength of concrete.
-. Vuz = 123.49 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1102.35 kN.
-. phiVcz = phi * Vcz = 992.12 kN.

-. Vuy = 311.21 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1058.97 kN.
-. phiVcy = phi * Vcy = 953.07 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2042.84 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6046.13 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2042.84 kN.
-. phiVsz = phi*Vsz = 1838.56 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2014.00 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6089.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2014.00 kN.
-. phiVsy = phi*Vsy = 1812.60 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 334.813 kN.
-. Vr = 2765.666 kN.
-. Ratio = Vu / Vr = 0.121 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 372.01 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 372.01 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0045 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0045 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0045 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116010,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                -0.00         0.00         0.00         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL             -0.00         0.00         0.00         0.00         0.00
            Others          1165.42      1341.14      1264.99      2159.94      1990.82
           ---------------------------------------------------------------------------
            DL+LL+Others    1165.42      1341.14      1264.99      2159.94      1990.82
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1264.99 kN-m.
           -. End Moments (My2) =     1341.14 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1341.14 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1341.14 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1990.82 kN-m.
          -. End Moments (Mz2) =     2159.94 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     2159.94 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     2159.94 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2373.261 kN.
          -. Mry        =      2716.309 kN-m.
          -. Mrz        =      4375.515 kN-m.
          -. Mr         =      5150.094 kN-m.
          -. Pu/Pr      =   0.491  --->  O.K !
          -. Muy/Mry    =   0.494  --->  O.K !
          -. Muz/Mrz    =   0.494  --->  O.K !
          -. Mu/Mr      =   0.494  --->  O.K !
          -. Ratio      =   0.494  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2854.31 kN.
          -. Vuz    =        150.22 kN.
          -. Muy    =      -1302.47 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47

          -. Vuy    =        344.99 kN.
          -. Muz    =      -2168.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.38
```

( ). Compute shear strength of concrete.
-. Vuz = 150.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1117.61 kN.
-. phiVcz = phi * Vcz = 1005.85 kN.

-. Vuy = 344.99 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1074.23 kN.
-. phiVcy = phi * Vcy = 966.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2052.58 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6030.87 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2052.58 kN.
-. phiVsz = phi*Vsz = 1847.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2024.35 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6074.26 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2024.35 kN.
-. phiVsy = phi*Vsy = 1821.91 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 376.280 kN.
-. Vr = 2788.719 kN.
-. Ratio = Vu / Vr = 0.135 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 418.09 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 418.09 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0040 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116011,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1177.41      1264.99      1177.57      1990.82      1809.07
           ---------------------------------------------------------------------------
            DL+LL+Others     1177.41      1264.99      1177.57      1990.82      1809.07
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1177.57 kN-m.
           -. End Moments (My2) =     1264.99 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1264.99 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1264.99 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1809.07 kN-m.
          -. End Moments (Mz2) =     1990.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1990.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1990.82 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2571.593 kN.
          -. Mry        =      2768.022 kN-m.
          -. Mrz        =      4356.267 kN-m.
          -. Mr         =      5161.299 kN-m.
          -. Pu/Pr      =   0.458  --->  O.K !
          -. Muy/Mry    =   0.457  --->  O.K !
          -. Muz/Mrz    =   0.457  --->  O.K !
          -. Mu/Mr      =   0.458  --->  O.K !
          -. Ratio      =   0.458  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2870.97 kN.
          -. Vuz    =        170.29 kN.
          -. Muy    =      -1228.43 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.23 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.52

          -. Vuy    =        368.33 kN.
          -. Muz    =      -1999.25 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.42
```

( ). Compute shear strength of concrete.
-. Vuz = 170.29 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1137.86 kN.
-. phiVcz = phi * Vcz = 1024.08 kN.

-. Vuy = 368.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1094.51 kN.
-. phiVcy = phi * Vcy = 985.06 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2065.20 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6010.62 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2065.20 kN.
-. phiVsz = phi*Vsz = 1858.68 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2037.76 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6053.97 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2037.76 kN.
-. phiVsy = phi*Vsy = 1833.98 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 405.791 kN.
-. Vr = 2819.044 kN.
-. Ratio = Vu / Vr = 0.144 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 450.88 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 450.88 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116012,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           1189.40      1177.57      1082.23      1809.07      1619.23
           ------------------------------------------------------------------------------
            DL+LL+Others     1189.40      1177.57      1082.23      1809.07      1619.23
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1082.23 kN-m.
           -. End Moments (My2) =     1177.57 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     1177.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     1177.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1619.23 kN-m.
          -. End Moments (Mz2) =     1809.07 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     1809.07 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     1809.07 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      2852.461 kN.
          -. Mry        =      2812.864 kN-m.
          -. Mrz        =      4342.738 kN-m.
          -. Mr         =      5174.126 kN-m.
          -. Pu/Pr      =   0.417  --->  O.K !
          -. Muy/Mry    =   0.419  --->  O.K !
          -. Muz/Mrz    =   0.417  --->  O.K !
          -. Mu/Mr      =   0.419  --->  O.K !
          -. Ratio      =   0.419  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2887.64 kN.
          -. Vuz    =        185.59 kN.
          -. Muy    =      -1143.46 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.04 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.57

          -. Vuy    =        382.96 kN.
          -. Muz    =      -1817.57 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.38 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48
```

( ). Compute shear strength of concrete.
-. Vuz = 185.59 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1162.40 kN.
-. phiVcz = phi * Vcz = 1046.16 kN.

-. Vuy = 382.96 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1119.13 kN.
-. phiVcy = phi * Vcy = 1007.22 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2080.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5986.08 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2080.04 kN.
-. phiVsz = phi*Vsz = 1872.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2053.54 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6029.35 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2053.54 kN.
-. phiVsy = phi*Vsy = 1848.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 425.559 kN.
-. Vr = 2855.407 kN.
-. Ratio = Vu / Vr = 0.149 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 472.84 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 472.84 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116013,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2904.30     -1050.81      -938.13     -1627.69     -1419.80
           ------------------------------------------------------------------------------
            DL+LL+Others     2904.30     -1050.81      -938.13     -1627.69     -1419.80
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      938.13 kN-m.
           -. End Moments (My2) =     1050.81 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1050.81 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1050.81 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1419.80 kN-m.
          -. End Moments (Mz2) =     1627.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1627.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1627.69 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      7617.868 kN.
          -. Mry        =      2756.106 kN-m.
          -. Mrz        =      4268.102 kN-m.
          -. Mr         =      5080.631 kN-m.
          -. Pu/Pr      =   0.381  --->  O.K !
          -. Muy/Mry    =   0.381  --->  O.K !
          -. Muz/Mrz    =   0.381  --->  O.K !
          -. Mu/Mr      =   0.381  --->  O.K !
          -. Ratio      =   0.381  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2904.30 kN.
          -. Vuz    =        225.47 kN.
          -. Muy    =      -1050.81 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.63

          -. Vuy    =        415.89 kN.
          -. Muz    =      -1627.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53
```

( ). Compute shear strength of concrete.
-. Vuz = 225.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1186.05 kN.
-. phiVcz = phi * Vcz = 1067.44 kN.

-. Vuy = 415.89 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1142.90 kN.
-. phiVcy = phi * Vcy = 1028.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2093.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5962.44 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2093.89 kN.
-. phiVsz = phi*Vsz = 1884.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2068.29 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6005.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2068.29 kN.
-. phiVsy = phi*Vsy = 1861.46 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 473.082 kN.
-. Vr = 2890.064 kN.
-. Ratio = Vu / Vr = 0.164 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 525.65 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 525.65 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0023 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116014,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2920.96      -938.13      -812.94     -1419.80     -1205.13
           ------------------------------------------------------------------------------
            DL+LL+Others     2920.96      -938.13      -812.94     -1419.80     -1205.13
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      812.94 kN-m.
           -. End Moments (My2) =      938.13 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -938.13 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -938.13 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =     1205.13 kN-m.
          -. End Moments (Mz2) =     1419.80 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =    -1419.80 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =    -1419.80 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      8575.469 kN.
          -. Mry        =      2729.694 kN-m.
          -. Mrz        =      4127.758 kN-m.
          -. Mr         =      4948.698 kN-m.
          -. Pu/Pr      =   0.341  --->  O.K !
          -. Muy/Mry    =   0.344  --->  O.K !
          -. Muz/Mrz    =   0.344  --->  O.K !
          -. Mu/Mr      =   0.344  --->  O.K !
          -. Ratio      =   0.344  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2920.96 kN.
          -. Vuz    =        250.44 kN.
          -. Muy    =       -938.13 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.64 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70

          -. Vuy    =        429.41 kN.
          -. Muz    =      -1419.80 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.95 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.60
```

( ). Compute shear strength of concrete.
-. Vuz = 250.44 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1217.88 kN.
-. phiVcz = phi * Vcz = 1096.09 kN.

-. Vuy = 429.41 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1174.96 kN.
-. phiVcy = phi * Vcy = 1057.46 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2111.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5930.61 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2111.88 kN.
-. phiVsz = phi*Vsz = 1900.69 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2087.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5973.53 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2087.45 kN.
-. phiVsy = phi*Vsy = 1878.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 497.102 kN.
-. Vr = 2936.162 kN.
-. Ratio = Vu / Vr = 0.169 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 552.34 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 552.34 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116015,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2897.85     -1197.10     -1005.18      -840.12      -693.60
           ------------------------------------------------------------------------------
            DL+LL+Others     2897.85     -1197.10     -1005.18      -840.12      -693.60
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =     1005.18 kN-m.
           -. End Moments (My2) =     1197.10 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1197.10 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1197.10 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      693.60 kN-m.
          -. End Moments (Mz2) =      840.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -840.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -840.12 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =      9639.095 kN.
          -. Mry        =      3978.064 kN-m.
          -. Mrz        =      2790.194 kN-m.
          -. Mr         =      4859.031 kN-m.
          -. Pu/Pr      =   0.301  --->  O.K !
          -. Muy/Mry    =   0.301  --->  O.K !
          -. Muz/Mrz    =   0.301  --->  O.K !
          -. Mu/Mr      =   0.301  --->  O.K !
          -. Ratio      =   0.301  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2937.62 kN.
          -. Vuz    =        258.76 kN.
          -. Muy    =       -812.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.38 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78

          -. Vuy    =        421.70 kN.
          -. Muz    =      -1205.13 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.66 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69
```

( ). Compute shear strength of concrete.
-. Vuz = 258.76 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1257.33 kN.
-. phiVcz = phi * Vcz = 1131.60 kN.

-. Vuy = 421.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1214.80 kN.
-. phiVcy = phi * Vcy = 1093.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2133.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5891.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2133.19 kN.
-. phiVsz = phi*Vsz = 1919.87 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2110.17 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5933.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2110.17 kN.
-. phiVsy = phi*Vsy = 1899.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 494.759 kN.
-. Vr = 2992.470 kN.
-. Ratio = Vu / Vr = 0.165 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 549.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 549.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116016,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2914.50     -1005.18      -817.22      -693.60      -555.02
           ------------------------------------------------------------------------------
            DL+LL+Others     2914.50     -1005.18      -817.22      -693.60      -555.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      817.22 kN-m.
           -. End Moments (My2) =     1005.18 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =    -1005.18 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =    -1005.18 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      555.02 kN-m.
          -. End Moments (Mz2) =      693.60 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -693.60 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -693.60 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     11312.944 kN.
          -. Mry        =      3877.259 kN-m.
          -. Mrz        =      2672.395 kN-m.
          -. Mr         =      4709.016 kN-m.
          -. Pu/Pr      =   0.258  --->  O.K !
          -. Muy/Mry    =   0.259  --->  O.K !
          -. Muz/Mrz    =   0.260  --->  O.K !
          -. Mu/Mr      =   0.260  --->  O.K !
          -. Ratio      =   0.260  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2954.28 kN.
          -. Vuz    =        254.22 kN.
          -. Muy    =       -683.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88

          -. Vuy    =        398.35 kN.
          -. Muz    =       -994.31 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.36 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.79
```

( ). Compute shear strength of concrete.
-. Vuz = 254.22 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1302.34 kN.
-. phiVcz = phi * Vcz = 1172.10 kN.

-. Vuy = 398.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1260.38 kN.
-. phiVcy = phi * Vcy = 1134.34 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2156.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5846.15 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2156.26 kN.
-. phiVsz = phi*Vsz = 1940.64 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2134.80 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5888.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2134.80 kN.
-. phiVsy = phi*Vsy = 1921.32 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 472.559 kN.
-. Vr = 3055.660 kN.
-. Ratio = Vu / Vr = 0.155 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 525.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 525.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-8.5062e-006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =1.5649e-006 m^2.
-. As_req = MAX[Asy_req, Asz_req] =1.5649e-006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116017,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2931.16      -817.22      -640.23      -555.02      -428.27
           ------------------------------------------------------------------------------
            DL+LL+Others     2931.16      -817.22      -640.23      -555.02      -428.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      640.23 kN-m.
           -. End Moments (My2) =      817.22 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -817.22 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -817.22 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      428.27 kN-m.
          -. End Moments (Mz2) =      555.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -555.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -555.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     13345.303 kN.
           -. Mry        =      3725.447 kN-m.
           -. Mrz        =      2525.312 kN-m.
           -. Mr         =      4500.684 kN-m.
           -. Pu/Pr      =   0.220  --->  O.K !
           -. Muy/Mry    =   0.219  --->  O.K !
           -. Muz/Mrz    =   0.220  --->  O.K !
           -. Mu/Mr      =   0.220  --->  O.K !
           -. Ratio      =   0.220  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       2970.94 kN.
           -. Vuz    =        239.98 kN.
           -. Muy    =       -556.48 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  31.82 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.99

           -. Vuy    =        363.96 kN.
           -. Muz    =       -795.15 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.06 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.90
```

( ). Compute shear strength of concrete.
-. Vuz = 239.98 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1350.96 kN.
-. phiVcz = phi * Vcz = 1215.87 kN.

-. Vuy = 363.96 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1309.81 kN.
-. phiVcy = phi * Vcy = 1178.83 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2179.83 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5797.52 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2179.83 kN.
-. phiVsz = phi*Vsz = 1961.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2159.97 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5838.68 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2159.97 kN.
-. phiVsy = phi*Vsy = 1943.98 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 435.958 kN.
-. Vr = 3122.807 kN.
-. Ratio = Vu / Vr = 0.140 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 484.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 484.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116018,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2947.82      -640.23      -479.38      -428.27      -315.99
           ------------------------------------------------------------------------------
            DL+LL+Others     2947.82      -640.23      -479.38      -428.27      -315.99
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      479.38 kN-m.
           -. End Moments (My2) =      640.23 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -640.23 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -640.23 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      315.99 kN-m.
          -. End Moments (Mz2) =      428.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -428.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -428.27 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     15824.721 kN.
          -. Mry        =      3469.632 kN-m.
          -. Mrz        =      2318.324 kN-m.
          -. Mr         =      4172.885 kN-m.
          -. Pu/Pr      =   0.186  --->  O.K !
          -. Muy/Mry    =   0.185  --->  O.K !
          -. Muz/Mrz    =   0.185  --->  O.K !
          -. Mu/Mr      =   0.186  --->  O.K !
          -. Ratio      =   0.186  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2947.82 kN.
          -. Vuz    =        321.69 kN.
          -. Muy    =       -640.23 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.56 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.10

          -. Vuy    =        224.57 kN.
          -. Muz    =       -428.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.77 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01
```

( ). Compute shear strength of concrete.
-. Vuz = 321.69 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1400.74 kN.
-. phiVcz = phi * Vcz = 1260.67 kN.

-. Vuy = 224.57 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1360.59 kN.
-. phiVcy = phi * Vcy = 1224.53 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2202.60 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5747.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2202.60 kN.
-. phiVsz = phi*Vsz = 1982.34 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2184.34 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5787.89 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2184.34 kN.
-. phiVsy = phi*Vsy = 1965.90 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 392.324 kN.
-. Vr = 3190.439 kN.
-. Ratio = Vu / Vr = 0.123 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 435.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 435.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116019,  LCB = 151-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2964.48      -479.38      -338.35      -315.99      -219.83
           ------------------------------------------------------------------------------
            DL+LL+Others     2964.48      -479.38      -338.35      -315.99      -219.83
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      338.35 kN-m.
           -. End Moments (My2) =      479.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -479.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -479.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      219.83 kN-m.
          -. End Moments (Mz2) =      315.99 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -315.99 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -315.99 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     18884.907 kN.
          -. Mry        =      3044.556 kN-m.
          -. Mrz        =      2000.953 kN-m.
          -. Mr         =      3643.231 kN-m.
          -. Pu/Pr      =   0.157  --->  O.K !
          -. Muy/Mry    =   0.157  --->  O.K !
          -. Muz/Mrz    =   0.158  --->  O.K !
          -. Mu/Mr      =   0.158  --->  O.K !
          -. Ratio      =   0.158  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2964.48 kN.
          -. Vuz    =        282.06 kN.
          -. Muy    =       -479.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.21

          -. Vuy    =        192.33 kN.
          -. Muz    =       -315.99 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.50 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.13
```

( ). Compute shear strength of concrete.
-. Vuz = 282.06 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1450.96 kN.
-. phiVcz = phi * Vcz = 1305.86 kN.

-. Vuy = 192.33 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1412.02 kN.
-. phiVcy = phi * Vcy = 1270.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2224.31 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5697.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2224.31 kN.
-. phiVsz = phi*Vsz = 2001.88 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2207.59 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5736.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2207.59 kN.
-. phiVsy = phi*Vsy = 1986.83 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 341.390 kN.
-. Vr = 3257.648 kN.
-. Ratio = Vu / Vr = 0.105 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 379.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 379.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0022 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116020,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3756.29       -61.03       -39.91       -28.93       -18.88
           ------------------------------------------------------------------------------
            DL+LL+Others     3756.29       -61.03       -39.91       -28.93       -18.88
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       39.91 kN-m.
           -. End Moments (My2) =       61.03 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -39.91 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -39.91 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       18.88 kN-m.
          -. End Moments (Mz2) =       28.93 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -18.88 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -18.88 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       259.384 kN-m.
          -. Mrz        =       122.515 kN-m.
          -. Mr         =       286.863 kN-m.
          -. Pu/Pr      =   0.154  --->  O.K !
          -. Muy/Mry    =   0.154  --->  O.K !
          -. Muz/Mrz    =   0.154  --->  O.K !
          -. Mu/Mr      =   0.154  --->  O.K !
          -. Ratio      =   0.154  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2981.14 kN.
          -. Vuz    =        237.26 kN.
          -. Muy    =       -338.35 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.32

          -. Vuy    =        158.23 kN.
          -. Muz    =       -219.83 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.25 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.24
```

( ). Compute shear strength of concrete.
-. Vuz = 237.26 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1499.91 kN.
-. phiVcz = phi * Vcz = 1349.92 kN.

-. Vuy = 158.23 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1462.34 kN.
-. phiVcy = phi * Vcy = 1316.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2244.35 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5648.57 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2244.35 kN.
-. phiVsz = phi*Vsz = 2019.91 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2229.07 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5686.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2229.07 kN.
-. phiVsy = phi*Vsy = 2006.16 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 285.183 kN.
-. Vr = 3322.263 kN.
-. Ratio = Vu / Vr = 0.086 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 316.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 316.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116021,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3772.94       -39.91       -22.92       -18.88       -10.83
           ------------------------------------------------------------------------------
            DL+LL+Others     3772.94       -39.91       -22.92       -18.88       -10.83
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       22.92 kN-m.
           -. End Moments (My2) =       39.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -22.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -22.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       10.83 kN-m.
          -. End Moments (Mz2) =       18.88 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -10.83 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -10.83 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       148.329 kN-m.
          -. Mrz        =        69.929 kN-m.
          -. Mr         =       163.986 kN-m.
          -. Pu/Pr      =   0.155  --->  O.K !
          -. Muy/Mry    =   0.155  --->  O.K !
          -. Muz/Mrz    =   0.155  --->  O.K !
          -. Mu/Mr      =   0.155  --->  O.K !
          -. Ratio      =   0.155  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       2997.80 kN.
          -. Vuz    =        188.81 kN.
          -. Muy    =       -219.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.42

          -. Vuy    =        123.24 kN.
          -. Muz    =       -140.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.04 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.34
```

( ). Compute shear strength of concrete.
-. Vuz = 188.81 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1545.90 kN.
-. phiVcz = phi * Vcz = 1391.31 kN.

-. Vuy = 123.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1509.78 kN.
-. phiVcy = phi * Vcy = 1358.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2262.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5602.58 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2262.24 kN.
-. phiVsz = phi*Vsz = 2036.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2248.26 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5638.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2248.26 kN.
-. phiVsy = phi*Vsy = 2023.43 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 225.470 kN.
-. Vr = 3382.235 kN.
-. Ratio = Vu / Vr = 0.067 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 250.52 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 250.52 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116022,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3789.60       -22.92       -10.41       -10.83        -4.91
           ------------------------------------------------------------------------------
            DL+LL+Others     3789.60       -22.92       -10.41       -10.83        -4.91
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       10.41 kN-m.
           -. End Moments (My2) =       22.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -10.41 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -10.41 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        4.91 kN-m.
          -. End Moments (Mz2) =       10.83 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -4.91 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -4.91 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        67.073 kN-m.
          -. Mrz        =        31.563 kN-m.
          -. Mr         =        74.129 kN-m.
          -. Pu/Pr      =   0.155  --->  O.K !
          -. Muy/Mry    =   0.155  --->  O.K !
          -. Muz/Mrz    =   0.156  --->  O.K !
          -. Mu/Mr      =   0.156  --->  O.K !
          -. Ratio      =   0.156  --->  O.K !

 ================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3031.11 kN.
          -. Vuz    =        137.63 kN.
          -. Muy    =        -56.51 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.51

          -. Vuy    =         87.97 kN.
          -. Muz    =        -35.12 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.85 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.44
```

( ). Compute shear strength of concrete.
-. Vuz = 137.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1587.32 kN.
-. phiVcz = phi * Vcz = 1428.59 kN.

-. Vuy = 87.97 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1552.64 kN.
-. phiVcy = phi * Vcy = 1397.37 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2277.62 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5561.17 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2277.62 kN.
-. phiVsz = phi*Vsz = 2049.86 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2264.78 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5595.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2264.78 kN.
-. phiVsy = phi*Vsy = 2038.30 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 163.343 kN.
-. Vr = 3435.679 kN.
-. Ratio = Vu / Vr = 0.048 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 181.49 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 181.49 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0043 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0043 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0043 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116023,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3806.25       -10.41        -2.68        -4.91        -1.27
           ------------------------------------------------------------------------------
            DL+LL+Others     3806.25       -10.41        -2.68        -4.91        -1.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        2.68 kN-m.
           -. End Moments (My2) =       10.41 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -2.68 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -2.68 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        1.27 kN-m.
          -. End Moments (Mz2) =        4.91 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -1.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -1.27 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        17.158 kN-m.
          -. Mrz        =         8.127 kN-m.
          -. Mr         =        18.985 kN-m.
          -. Pu/Pr      =   0.156  --->  O.K !
          -. Muy/Mry    =   0.156  --->  O.K !
          -. Muz/Mrz    =   0.156  --->  O.K !
          -. Mu/Mr      =   0.156  --->  O.K !
          -. Ratio      =   0.156  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3047.77 kN.
          -. Vuz    =         84.23 kN.
          -. Muy    =        -14.39 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.58

          -. Vuy    =         52.70 kN.
          -. Muz    =         -8.77 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.73 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.50
```

( ). Compute shear strength of concrete.
-. Vuz = 84.23 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1615.44 kN.
-. phiVcz = phi * Vcz = 1453.89 kN.

-. Vuy = 52.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1581.81 kN.
-. phiVcy = phi * Vcy = 1423.63 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2287.70 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5533.05 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2287.70 kN.
-. phiVsz = phi*Vsz = 2058.93 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2275.62 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5566.67 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2275.62 kN.
-. phiVsy = phi*Vsy = 2048.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 99.363 kN.
-. Vr = 3471.685 kN.
-. Ratio = Vu / Vr = 0.029 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 110.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 110.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =116024,  LCB = 148-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 148-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           3822.91        -2.68         0.00        -1.27         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     3822.91        -2.68         0.00        -1.27         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        2.68 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        1.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.157  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.157  --->  O.K !
          -. Ratio      =   0.157  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       3064.42 kN.
          -. Vuz    =         28.78 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.57

          -. Vuy    =         17.54 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  30.61 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.57
```

( ). Compute shear strength of concrete.
-. Vuz = 28.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1612.97 kN.
-. phiVcz = phi * Vcz = 1451.68 kN.

-. Vuy = 17.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1612.97 kN.
-. phiVcy = phi * Vcy = 1451.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2286.83 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5535.51 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2286.83 kN.
-. phiVsz = phi*Vsz = 2058.15 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2286.83 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5535.51 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2286.83 kN.
-. phiVsy = phi*Vsy = 2058.15 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 33.702 kN.
-. Vr = 3509.824 kN.
-. Ratio = Vu / Vr = 0.010 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 37.45 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 37.45 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0049 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0049 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0049 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117102,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -822.96      1338.47      1649.01       733.32       892.24
           ---------------------------------------------------------------------------
           DL+LL+Others     -822.96      1338.47      1649.01       733.32       892.24
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1961.736 kN.
          -. Mry        =      3907.175 kN-m.
          -. Mrz        =      2115.901 kN-m.
          -. Mr         =      4443.316 kN-m.
          -. Pu/Pr      =   0.420  --->  O.K !
          -. Muy/Mry    =   0.422  --->  O.K !
          -. Muz/Mrz    =   0.422  --->  O.K !
          -. Mu/Mr      =   0.422  --->  O.K !
          -. Ratio      =   0.422  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4981.05 kN.
          -. Vuz    =        467.69 kN.
          -. Muy    =      -1119.40 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.96 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.33
```

```
          -. Vuy    =       1182.38 kN.
          -. Muz    =       -788.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.37 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.23

     ( ). Compute shear strength of concrete.
          -. Vuz       =      467.69 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1051.29 kN.
          -. phiVcz    = phi * Vcz =      946.16 kN.

          -. Vuy       =     1182.38 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1008.01 kN.
          -. phiVcy    = phi * Vcy =      907.21 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz > phiVcz  --->  Required shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy > phiVcy  --->  Required shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2008.71 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6097.19 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2008.71 kN.
          -. phiVsz   = phi*Vsz =     1807.84 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1977.77 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6140.47 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1977.77 kN.
          -. phiVsy   = phi*Vsy =     1779.99 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =    1271.514 kN.
          -. Vr       =    2687.202 kN.
          -. Ratio    = Vu / Vr = 0.473  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1412.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1412.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117103,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1589.80      1212.08      1386.68      1046.51      1512.19
           ---------------------------------------------------------------------------
            DL+LL+Others    -1589.80      1212.08      1386.68      1046.51      1512.19
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3166.595 kN.
          -. Mry        =      2764.339 kN-m.
          -. Mrz        =      3015.975 kN-m.
          -. Mr         =      4091.171 kN-m.
          -. Pu/Pr      =   0.502  --->  O.K !
          -. Muy/Mry    =   0.502  --->  O.K !
          -. Muz/Mrz    =   0.501  --->  O.K !
          -. Mu/Mr      =   0.502  --->  O.K !
          -. Ratio      =   0.502  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4997.87 kN.
          -. Vuz    =        394.59 kN.
          -. Muy    =      -1295.28 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.24
```

-. Vuy = 1043.03 kN.
-. Muz = -1289.01 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.76 Deg. [Clause 5.8.3.4.2]
-. betay = 2.15

( ). Compute shear strength of concrete.
-. Vuz = 394.59 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1013.93 kN.
-. phiVcz = phi * Vcz = 912.53 kN.

-. Vuy = 1043.03 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 970.85 kN.
-. phiVcy = phi * Vcy = 873.76 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1982.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6134.56 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1982.11 kN.
-. phiVsz = phi*Vsz = 1783.90 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1949.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6177.64 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1949.57 kN.
-. phiVsy = phi*Vsy = 1754.62 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1115.173 kN.
-. Vr = 2628.382 kN.
-. Ratio = Vu / Vr = 0.424 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1239.08 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1239.08 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117104,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1577.96      1386.68      1510.27      1512.19      1892.39
           ------------------------------------------------------------------------------
            DL+LL+Others    -1577.96      1386.68      1510.27      1512.19      1892.39
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2734.886 kN.
          -. Mry        =      2624.319 kN-m.
          -. Mrz        =      3298.213 kN-m.
          -. Mr         =      4214.885 kN-m.
          -. Pu/Pr      =   0.577  --->  O.K !
          -. Muy/Mry    =   0.575  --->  O.K !
          -. Muz/Mrz    =   0.574  --->  O.K !
          -. Mu/Mr      =   0.577  --->  O.K !
          -. Ratio      =   0.577  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5014.69 kN.
          -. Vuz    =        284.00 kN.
          -. Muy    =      -1421.63 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
```

-. Vuy = 828.08 kN.
-. Muz = -1702.65 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.98 Deg. [Clause 5.8.3.4.2]
-. betay = 2.10

( ). Compute shear strength of concrete.
-. Vuz = 284.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 993.53 kN.
-. phiVcz = phi * Vcz = 894.18 kN.

-. Vuy = 828.08 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 950.60 kN.
-. phiVcy = phi * Vcy = 855.54 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1966.96 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6154.96 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1966.96 kN.
-. phiVsz = phi*Vsz = 1770.27 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1933.54 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6197.88 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1933.54 kN.
-. phiVsy = phi*Vsy = 1740.18 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 875.426 kN.
-. Vr = 2595.728 kN.
-. Ratio = Vu / Vr = 0.337 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 972.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 972.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117105,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1566.12      1510.27      1586.76      1892.39      2170.74
           ---------------------------------------------------------------------------
           DL+LL+Others    -1566.12      1510.27      1586.76      1892.39      2170.74
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2495.706 kN.
          -. Mry        =      2523.260 kN-m.
          -. Mrz        =      3465.597 kN-m.
          -. Mr         =      4286.864 kN-m.
          -. Pu/Pr      =   0.628  --->  O.K !
          -. Muy/Mry    =   0.629  --->  O.K !
          -. Muz/Mrz    =   0.626  --->  O.K !
          -. Mu/Mr      =   0.629  --->  O.K !
          -. Ratio      =   0.629  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5031.49 kN.
          -. Vuz    =        173.69 kN.
          -. Muy    =      -1502.24 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
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```
          -. Vuy    =       608.00 kN.
          -. Muz    =     -2012.42 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.08

     ( ). Compute shear strength of concrete.
          -. Vuz       =     173.69 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      984.15 kN.
          -. phiVcz    = phi * Vcz =      885.74 kN.

          -. Vuy       =     608.00 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      941.31 kN.
          -. phiVcy    = phi * Vcy =      847.18 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1959.85 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6164.33 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1959.85 kN.
          -. phiVsz   = phi*Vsz =     1763.86 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1926.01 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6207.18 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1926.01 kN.
          -. phiVsy   = phi*Vsy =     1733.40 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     632.318 kN.
          -. Vr       =    2580.585 kN.
          -. Ratio    = Vu / Vr = 0.245  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 702.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 702.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117106,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1554.27      1586.76      1613.19      2170.74      2344.57
           ---------------------------------------------------------------------------
           DL+LL+Others    -1554.27      1586.76      1613.19      2170.74      2344.57
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2362.144 kN.
          -. Mry        =      2445.104 kN-m.
          -. Mrz        =      3569.935 kN-m.
          -. Mr         =      4327.005 kN-m.
          -. Pu/Pr      =   0.658  --->  O.K !
          -. Muy/Mry    =   0.660  --->  O.K !
          -. Muz/Mrz    =   0.657  --->  O.K !
          -. Mu/Mr      =   0.660  --->  O.K !
          -. Ratio      =   0.660  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5048.29 kN.
          -. Vuz    =         71.26 kN.
          -. Muy    =      -1533.98 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
```

```
          -. Vuy    =       390.69 kN.
          -. Muz    =     -2215.15 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.07 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.09

     ( ). Compute shear strength of concrete.
          -. Vuz       =       71.26 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      985.47 kN.
          -. phiVcz    = phi * Vcz =      886.92 kN.

          -. Vuy       =     390.69 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      942.61 kN.
          -. phiVcy    = phi * Vcy =      848.35 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1960.85 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6163.02 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1960.85 kN.
          -. phiVsz   = phi*Vsz =     1764.77 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1927.07 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6205.87 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1927.07 kN.
          -. phiVsy   = phi*Vsy =     1734.36 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     397.138 kN.
          -. Vr       =    2582.715 kN.
          -. Ratio    = Vu / Vr = 0.154  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 441.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 441.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117107,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1542.42      1613.19      1600.77      2344.57      2440.21
           ---------------------------------------------------------------------------
           DL+LL+Others    -1542.42      1613.19      1600.77      2344.57      2440.21
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2291.093 kN.
          -. Mry        =      2381.051 kN-m.
          -. Mrz        =      3637.040 kN-m.
          -. Mr         =      4347.121 kN-m.
          -. Pu/Pr      =   0.673  --->  O.K !
          -. Muy/Mry    =   0.672  --->  O.K !
          -. Muz/Mrz    =   0.671  --->  O.K !
          -. Mu/Mr      =   0.673  --->  O.K !
          -. Ratio      =   0.673  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =      -1542.42 kN.
          -. Vuz    =         50.87 kN.
          -. Muy    =       1600.77 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.96
```

```
          -. Vuy    =       283.69 kN.
          -. Muz    =      2440.21 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.96

     ( ). Compute shear strength of concrete.
          -. Vuz       =      50.87 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1335.86 kN.
          -. phiVcz    = phi * Vcz =     1202.27 kN.

          -. Vuy       =     283.69 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1335.86 kN.
          -. phiVcy    = phi * Vcy =     1202.27 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2172.65 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5812.63 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2172.65 kN.
          -. phiVsz   = phi*Vsz =     1955.39 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2172.65 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     5812.63 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2172.65 kN.
          -. phiVsy   = phi*Vsy =     1955.39 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     288.218 kN.
          -. Vr       =    3157.660 kN.
          -. Ratio    = Vu / Vr = 0.091  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.90
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 320.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 320.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0118 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0118 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0118 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117108,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1542.54      1600.77      1556.54      2440.21      2468.87
           ---------------------------------------------------------------------------
           DL+LL+Others    -1542.54      1600.77      1556.54      2440.21      2468.87
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2291.093 kN.
          -. Mry        =      2381.051 kN-m.
          -. Mrz        =      3637.040 kN-m.
          -. Mr         =      4347.121 kN-m.
          -. Pu/Pr      =   0.673  --->  O.K !
          -. Muy/Mry    =   0.672  --->  O.K !
          -. Muz/Mrz    =   0.671  --->  O.K !
          -. Mu/Mr      =   0.673  --->  O.K !
          -. Ratio      =   0.673  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       -763.66 kN.
          -. Vuz    =        127.40 kN.
          -. Muy    =       2241.49 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.89
```

-. Vuy = 149.49 kN.
-. Muz = 1706.24 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 32.09 Deg. [Clause 5.8.3.4.2]
-. betay = 2.89

( ). Compute shear strength of concrete.
-. Vuz = 127.40 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1304.67 kN.
-. phiVcz = phi * Vcz = 1174.20 kN.

-. Vuy = 149.49 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1304.67 kN.
-. phiVcy = phi * Vcy = 1174.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2157.43 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5843.82 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2157.43 kN.
-. phiVsz = phi*Vsz = 1941.68 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2157.43 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5843.82 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2157.43 kN.
-. phiVsy = phi*Vsy = 1941.68 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 196.410 kN.
-. Vr = 3115.887 kN.
-. Ratio = Vu / Vr = 0.063 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.90
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 218.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 218.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0102 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0102 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0102 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117109,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1530.67      1556.54      1487.02      2468.87      2442.16
           ---------------------------------------------------------------------------
           DL+LL+Others    -1530.67      1556.54      1487.02      2468.87      2442.16
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2290.165 kN.
          -. Mry        =      2319.124 kN-m.
          -. Mrz        =      3676.967 kN-m.
          -. Mr         =      4347.231 kN-m.
          -. Pu/Pr      =   0.668  --->  O.K !
          -. Muy/Mry    =   0.671  --->  O.K !
          -. Muz/Mrz    =   0.671  --->  O.K !
          -. Mu/Mr      =   0.671  --->  O.K !
          -. Ratio      =   0.671  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4303.07 kN.
          -. Vuz    =        182.74 kN.
          -. Muy    =      -2116.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.05 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.30
```

```
          -. Vuy    =         65.47 kN.
          -. Muz    =      -1641.82 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.47 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.21

     ( ). Compute shear strength of concrete.
          -. Vuz       =      182.74 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1041.31 kN.
          -. phiVcz    = phi * Vcz =      937.18 kN.

          -. Vuy       =       65.47 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      998.07 kN.
          -. phiVcy    = phi * Vcy =      898.27 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2001.74 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6107.18 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2001.74 kN.
          -. phiVsz   = phi*Vsz =     1801.57 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1970.38 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6150.41 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1970.38 kN.
          -. phiVsy   = phi*Vsy =     1773.34 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     194.117 kN.
          -. Vr       =    2671.607 kN.
          -. Ratio    = Vu / Vr = 0.073  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 215.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 215.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117110,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1518.80      1487.02      1402.05      2442.16      2379.51
           ---------------------------------------------------------------------------
           DL+LL+Others    -1518.80      1487.02      1402.05      2442.16      2379.51
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2291.588 kN.
          -. Mry        =      2265.034 kN-m.
          -. Mrz        =      3710.333 kN-m.
          -. Mr         =      4347.062 kN-m.
          -. Pu/Pr      =   0.663  --->  O.K !
          -. Muy/Mry    =   0.657  --->  O.K !
          -. Muz/Mrz    =   0.658  --->  O.K !
          -. Mu/Mr      =   0.663  --->  O.K !
          -. Ratio      =   0.663  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4319.81 kN.
          -. Vuz    =        225.97 kN.
          -. Muy    =      -2029.36 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.31
```

```
          -. Vuy    =         86.79 kN.
          -. Muz    =      -1641.23 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.45 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.21

     ( ). Compute shear strength of concrete.
          -. Vuz       =      225.97 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1043.64 kN.
          -. phiVcz    = phi * Vcz =      939.28 kN.

          -. Vuy       =       86.79 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1000.40 kN.
          -. phiVcy    = phi * Vcy =      900.36 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2003.38 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6104.85 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2003.38 kN.
          -. phiVsz   = phi*Vsz =     1803.04 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1972.11 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6148.09 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1972.11 kN.
          -. phiVsy   = phi*Vsy =     1774.90 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     242.060 kN.
          -. Vr       =    2675.260 kN.
          -. Ratio    = Vu / Vr = 0.090  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 268.96 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 268.96 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117111,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1506.91      1402.05      1305.74      2379.51      2289.44
           ---------------------------------------------------------------------------
           DL+LL+Others    -1506.91      1402.05      1305.74      2379.51      2289.44
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2360.931 kN.
          -. Mry        =      2203.733 kN-m.
          -. Mrz        =      3723.937 kN-m.
          -. Mr         =      4327.141 kN-m.
          -. Pu/Pr      =   0.638  --->  O.K !
          -. Muy/Mry    =   0.636  --->  O.K !
          -. Muz/Mrz    =   0.639  --->  O.K !
          -. Mu/Mr      =   0.639  --->  O.K !
          -. Ratio      =   0.639  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4336.54 kN.
          -. Vuz    =        257.78 kN.
          -. Muy    =      -1919.76 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.97 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.33
```

-. Vuy = 114.28 kN.
-. Muz = -1615.19 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.38 Deg. [Clause 5.8.3.4.2]
-. betay = 2.23

( ). Compute shear strength of concrete.
-. Vuz = 257.78 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1050.55 kN.
-. phiVcz = phi * Vcz = 945.50 kN.

-. Vuy = 114.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1007.28 kN.
-. phiVcy = phi * Vcy = 906.55 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2008.19 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6097.94 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2008.19 kN.
-. phiVsz = phi*Vsz = 1807.38 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1977.22 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6141.21 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1977.22 kN.
-. phiVsy = phi*Vsy = 1779.50 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 281.975 kN.
-. Vr = 2686.047 kN.
-. Ratio = Vu / Vr = 0.105 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 313.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 313.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117112,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1495.02      1305.74      1201.67      2289.44      2181.28
           ---------------------------------------------------------------------------
           DL+LL+Others    -1495.02      1305.74      1201.67      2289.44      2181.28
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2432.225 kN.
          -. Mry        =      2143.052 kN-m.
          -. Mrz        =      3735.907 kN-m.
          -. Mr         =      4306.933 kN-m.
          -. Pu/Pr      =   0.615  --->  O.K !
          -. Muy/Mry    =   0.609  --->  O.K !
          -. Muz/Mrz    =   0.613  --->  O.K !
          -. Mu/Mr      =   0.615  --->  O.K !
          -. Ratio      =   0.615  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4353.27 kN.
          -. Vuz    =        279.82 kN.
          -. Muy    =      -1793.78 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

```
          -. Vuy    =       138.28 kN.
          -. Muz    =     -1569.59 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.27 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.25

     ( ). Compute shear strength of concrete.
          -. Vuz       =     279.82 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1061.44 kN.
          -. phiVcz    = phi * Vcz =      955.30 kN.

          -. Vuy       =     138.28 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1018.12 kN.
          -. phiVcy    = phi * Vcy =      916.31 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2015.69 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6087.05 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2015.69 kN.
          -. phiVsz   = phi*Vsz =     1814.12 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1985.17 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6130.36 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1985.17 kN.
          -. phiVsy   = phi*Vsy =     1786.65 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     312.120 kN.
          -. Vr       =    2702.965 kN.
          -. Ratio    = Vu / Vr = 0.115  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 346.80 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 346.80 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117113,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1483.12      1201.67      1073.83      2181.28      2008.44
           ---------------------------------------------------------------------------
           DL+LL+Others    -1483.12      1201.67      1073.83      2181.28      2008.44
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2534.591 kN.
          -. Mry        =      2072.260 kN-m.
          -. Mrz        =      3741.132 kN-m.
          -. Mr         =      4276.719 kN-m.
          -. Pu/Pr      =   0.585  --->  O.K !
          -. Muy/Mry    =   0.580  --->  O.K !
          -. Muz/Mrz    =   0.583  --->  O.K !
          -. Mu/Mr      =   0.585  --->  O.K !
          -. Ratio      =   0.585  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5149.02 kN.
          -. Vuz    =        243.97 kN.
          -. Muy    =      -1163.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.22
```

-. Vuy = 331.40 kN.
-. Muz = -2182.58 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.88 Deg. [Clause 5.8.3.4.2]
-. betay = 2.12

( ). Compute shear strength of concrete.
-. Vuz = 243.97 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1002.77 kN.
-. phiVcz = phi * Vcz = 902.50 kN.

-. Vuy = 331.40 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 959.78 kN.
-. phiVcy = phi * Vcy = 863.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1973.89 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6145.71 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1973.89 kN.
-. phiVsz = phi*Vsz = 1776.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1940.86 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6188.71 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1940.86 kN.
-. phiVsy = phi*Vsy = 1746.78 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 411.515 kN.
-. Vr = 2610.578 kN.
-. Ratio = Vu / Vr = 0.158 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 457.24 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 457.24 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117114,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1471.21      1073.83       933.70      2008.44      1792.10
           ------------------------------------------------------------------------------
            DL+LL+Others    -1471.21      1073.83       933.70      2008.44      1792.10
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2714.334 kN.
          -. Mry        =      2000.760 kN-m.
          -. Mrz        =      3721.921 kN-m.
          -. Mr         =      4225.604 kN-m.
          -. Pu/Pr      =   0.542  --->  O.K !
          -. Muy/Mry    =   0.537  --->  O.K !
          -. Muz/Mrz    =   0.540  --->  O.K !
          -. Mu/Mr      =   0.542  --->  O.K !
          -. Ratio      =   0.542  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5165.76 kN.
          -. Vuz    =        268.77 kN.
          -. Muy    =      -1042.65 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.30 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.25
```

```
          -. Vuy    =       422.94 kN.
          -. Muz    =     -2022.11 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.75 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.15

     ( ). Compute shear strength of concrete.
          -. Vuz       =      268.77 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1015.05 kN.
          -. phiVcz    = phi * Vcz =      913.55 kN.

          -. Vuy       =      422.94 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      971.97 kN.
          -. phiVcy    = phi * Vcy =      874.77 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1982.93 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6133.43 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1982.93 kN.
          -. phiVsz   = phi*Vsz =     1784.64 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1950.45 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6176.52 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1950.45 kN.
          -. phiVsy   = phi*Vsy =     1755.40 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     501.115 kN.
          -. Vr       =    2630.172 kN.
          -. Ratio    = Vu / Vr = 0.191  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 556.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 556.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117115,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1459.30       933.70       790.24      1792.10      1552.26
           ---------------------------------------------------------------------------
           DL+LL+Others    -1459.30       933.70       790.24      1792.10      1552.26
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2998.876 kN.
          -. Mry        =      1917.684 kN-m.
          -. Mrz        =      3672.288 kN-m.
          -. Mr         =      4142.850 kN-m.
          -. Pu/Pr      =   0.487  --->  O.K !
          -. Muy/Mry    =   0.487  --->  O.K !
          -. Muz/Mrz    =   0.488  --->  O.K !
          -. Mu/Mr      =   0.488  --->  O.K !
          -. Ratio      =   0.488  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5182.50 kN.
          -. Vuz    =        276.26 kN.
          -. Muy    =       -908.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.30
```

```
          -. Vuy    =       474.24 kN.
          -. Muz    =     -1813.64 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.20

     ( ). Compute shear strength of concrete.
          -. Vuz       =     276.26 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1037.17 kN.
          -. phiVcz    = phi * Vcz =      933.46 kN.

          -. Vuy       =     474.24 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      993.96 kN.
          -. phiVcy    = phi * Vcy =      894.56 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1998.83 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6111.31 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1998.83 kN.
          -. phiVsz   = phi*Vsz =     1798.94 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1967.29 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6154.53 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1967.29 kN.
          -. phiVsy   = phi*Vsy =     1770.56 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     548.839 kN.
          -. Vr       =    2665.125 kN.
          -. Ratio    = Vu / Vr = 0.206  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 609.82 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 609.82 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0010 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117116,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1447.38       790.24       650.24      1552.26      1304.75
           ---------------------------------------------------------------------------
           DL+LL+Others    -1447.38       790.24       650.24      1552.26      1304.75
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3341.219 kN.
          -. Mry        =      1828.099 kN-m.
          -. Mrz        =      3605.179 kN-m.
          -. Mr         =      4042.185 kN-m.
          -. Pu/Pr      =   0.433  --->  O.K !
          -. Muy/Mry    =   0.432  --->  O.K !
          -. Muz/Mrz    =   0.431  --->  O.K !
          -. Mu/Mr      =   0.433  --->  O.K !
          -. Ratio      =   0.433  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5199.23 kN.
          -. Vuz    =        270.66 kN.
          -. Muy    =       -770.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.82 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.36
```

-. Vuy = 493.36 kN.
-. Muz = -1577.97 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.22 Deg. [Clause 5.8.3.4.2]
-. betay = 2.27

( ). Compute shear strength of concrete.
-. Vuz = 270.66 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1066.90 kN.
-. phiVcz = phi * Vcz = 960.21 kN.

-. Vuy = 493.36 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1023.56 kN.
-. phiVcy = phi * Vcy = 921.21 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2019.40 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6081.59 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2019.40 kN.
-. phiVsz = phi*Vsz = 1817.46 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1989.11 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6124.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1989.11 kN.
-. phiVsy = phi*Vsy = 1790.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 562.724 kN.
-. Vr = 2711.407 kN.
-. Ratio = Vu / Vr = 0.208 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 625.25 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 625.25 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117117,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1435.45       650.24       518.67      1304.75      1061.80
           ---------------------------------------------------------------------------
           DL+LL+Others    -1435.45       650.24       518.67      1304.75      1061.80
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3817.074 kN.
          -. Mry        =      1733.058 kN-m.
          -. Mrz        =      3490.475 kN-m.
          -. Mr         =      3897.038 kN-m.
          -. Pu/Pr      =   0.376  --->  O.K !
          -. Muy/Mry    =   0.375  --->  O.K !
          -. Muz/Mrz    =   0.374  --->  O.K !
          -. Mu/Mr      =   0.376  --->  O.K !
          -. Ratio      =   0.376  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5215.95 kN.
          -. Vuz    =        255.29 kN.
          -. Muy    =       -635.45 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.51 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.44
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```
          -. Vuy    =       488.10 kN.
          -. Muz    =     -1331.70 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.89 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.34

     ( ). Compute shear strength of concrete.
          -. Vuz       =     255.29 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1102.29 kN.
          -. phiVcz    = phi * Vcz =      992.06 kN.

          -. Vuy       =     488.10 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1058.90 kN.
          -. phiVcy    = phi * Vcy =      953.01 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2042.80 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6046.20 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2042.80 kN.
          -. phiVsz   = phi*Vsz =     1838.52 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2013.95 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6089.59 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2013.95 kN.
          -. phiVsy   = phi*Vsy =     1812.55 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     550.829 kN.
          -. Vr       =    2765.563 kN.
          -. Ratio    = Vu / Vr = 0.199  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 612.03 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 612.03 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0027 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117118,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1423.51       518.67       398.98      1061.80       832.61
           ---------------------------------------------------------------------------
           DL+LL+Others    -1423.51       518.67       398.98      1061.80       832.61
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4457.303 kN.
          -. Mry        =      1618.162 kN-m.
          -. Mrz        =      3313.809 kN-m.
          -. Mr         =      3687.788 kN-m.
          -. Pu/Pr      =   0.319  --->  O.K !
          -. Muy/Mry    =   0.321  --->  O.K !
          -. Muz/Mrz    =   0.320  --->  O.K !
          -. Mu/Mr      =   0.321  --->  O.K !
          -. Ratio      =   0.321  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5232.66 kN.
          -. Vuz    =        232.97 kN.
          -. Muy    =       -507.84 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.20 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.53
```

```
          -. Vuy    =       463.77 kN.
          -. Muz    =     -1087.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.55 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.43

     ( ). Compute shear strength of concrete.
          -. Vuz       =     232.97 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1141.72 kN.
          -. phiVcz    = phi * Vcz =     1027.55 kN.

          -. Vuy       =     463.77 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1098.38 kN.
          -. phiVcy    = phi * Vcy =      988.54 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2067.57 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6006.76 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2067.57 kN.
          -. phiVsz   = phi*Vsz =     1860.81 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2040.27 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6050.11 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2040.27 kN.
          -. phiVsy   = phi*Vsy =     1836.25 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     518.994 kN.
          -. Vr       =    2824.790 kN.
          -. Ratio    = Vu / Vr = 0.184  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 576.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 576.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117119,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1411.57       398.98       293.48       832.61       624.00
           ---------------------------------------------------------------------------
           DL+LL+Others    -1411.57       398.98       293.48       832.61       624.00
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5224.346 kN.
          -. Mry        =      1485.799 kN-m.
          -. Mrz        =      3096.532 kN-m.
          -. Mr         =      3434.547 kN-m.
          -. Pu/Pr      =   0.270  --->  O.K !
          -. Muy/Mry    =   0.269  --->  O.K !
          -. Muz/Mrz    =   0.269  --->  O.K !
          -. Mu/Mr      =   0.270  --->  O.K !
          -. Ratio      =   0.270  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5249.36 kN.
          -. Vuz    =        205.93 kN.
          -. Muy    =       -391.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62
```

```
          -. Vuy    =        424.74 kN.
          -. Muz    =       -855.90 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.21 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.52

     ( ). Compute shear strength of concrete.
          -. Vuz       =      205.93 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1183.68 kN.
          -. phiVcz    = phi * Vcz =     1065.31 kN.

          -. Vuy       =      424.74 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1140.52 kN.
          -. phiVcy    = phi * Vcy =     1026.47 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2092.52 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5964.80 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2092.52 kN.
          -. phiVsz   = phi*Vsz =     1883.27 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2066.83 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6007.97 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2066.83 kN.
          -. phiVsy   = phi*Vsy =     1860.15 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     472.028 kN.
          -. Vr       =    2886.613 kN.
          -. Ratio    = Vu / Vr = 0.164  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 524.48 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 524.48 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0046 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0046 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0046 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117120,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5266.06      -288.43      -200.42      -643.56      -456.07
           ------------------------------------------------------------------------------
            DL+LL+Others     5266.06      -288.43      -200.42      -643.56      -456.07
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      200.42 kN-m.
           -. End Moments (My2) =      288.43 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -288.43 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -288.43 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      456.07 kN-m.
          -. End Moments (Mz2) =      643.56 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -643.56 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -643.56 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0321
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     24404.708 kN.
           -. Pr         =     21918.605 kN.
           -. Mry        =      1200.063 kN-m.
           -. Mrz        =      2678.047 kN-m.
           -. Mr         =      2934.636 kN-m.
           -. Pu/Pr      =   0.240  --->  O.K !
           -. Muy/Mry    =   0.240  --->  O.K !
           -. Muz/Mrz    =   0.240  --->  O.K !
           -. Mu/Mr      =   0.240  --->  O.K !
           -. Ratio      =   0.240  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0006 m^2.
           -. Pu     =       5266.06 kN.
           -. Vuz    =        176.03 kN.
           -. Muy    =       -288.43 kN-m.
           -. bvz    =   1.20 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
           -. thetaz =  32.58 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   2.72

           -. Vuy    =        375.00 kN.
           -. Muz    =       -643.56 kN-m.
           -. bvy    =   1.20 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
           -. thetay =  32.88 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   2.62
```

( ). Compute shear strength of concrete.
-. Vuz = 176.03 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1226.60 kN.
-. phiVcz = phi * Vcz = 1103.94 kN.

-. Vuy = 375.00 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1183.75 kN.
-. phiVcy = phi * Vcy = 1065.37 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2116.68 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5921.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2116.68 kN.
-. phiVsz = phi*Vsz = 1905.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2092.56 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5964.74 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2092.56 kN.
-. phiVsy = phi*Vsy = 1883.31 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 414.260 kN.
-. Vr = 2948.677 kN.
-. Ratio = Vu / Vr = 0.140 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 460.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 460.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0054 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0054 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0054 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117121,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5282.75      -200.42      -128.14      -456.07      -297.35
           ------------------------------------------------------------------------------
            DL+LL+Others     5282.75      -200.42      -128.14      -456.07      -297.35
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      128.14 kN-m.
           -. End Moments (My2) =      200.42 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -200.42 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -200.42 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      297.35 kN-m.
          -. End Moments (Mz2) =      456.07 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -456.07 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -456.07 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24125.243 kN.
          -. Mry        =       909.735 kN-m.
          -. Mrz        =      2073.503 kN-m.
          -. Mr         =      2264.295 kN-m.
          -. Pu/Pr      =   0.219  --->  O.K !
          -. Muy/Mry    =   0.220  --->  O.K !
          -. Muz/Mrz    =   0.220  --->  O.K !
          -. Mu/Mr      =   0.220  --->  O.K !
          -. Ratio      =   0.220  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5282.75 kN.
          -. Vuz    =        144.56 kN.
          -. Muy    =       -200.42 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81

          -. Vuy    =        317.46 kN.
          -. Muz    =       -456.07 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.71
```

( ). Compute shear strength of concrete.
-. Vuz = 144.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1268.93 kN.
-. phiVcz = phi * Vcz = 1142.04 kN.

-. Vuy = 317.46 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1226.53 kN.
-. phiVcy = phi * Vcy = 1103.88 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2139.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5879.56 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2139.26 kN.
-. phiVsz = phi*Vsz = 1925.33 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2116.64 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5921.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2116.64 kN.
-. phiVsy = phi*Vsy = 1904.98 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 348.831 kN.
-. Vr = 3008.853 kN.
-. Ratio = Vu / Vr = 0.116 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 387.59 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 387.59 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0062 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0062 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0062 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117122,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5316.09      -128.14       -71.94      -297.35      -170.27
           ------------------------------------------------------------------------------
            DL+LL+Others     5316.09      -128.14       -71.94      -297.35      -170.27
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       71.94 kN-m.
           -. End Moments (My2) =      128.14 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -71.94 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -71.94 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      170.27 kN-m.
          -. End Moments (Mz2) =      297.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -170.27 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -170.27 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       329.420 kN-m.
          -. Mrz        =       782.029 kN-m.
          -. Mr         =       848.579 kN-m.
          -. Pu/Pr      =   0.218  --->  O.K !
          -. Muy/Mry    =   0.218  --->  O.K !
          -. Muz/Mrz    =   0.218  --->  O.K !
          -. Mu/Mr      =   0.218  --->  O.K !
          -. Ratio      =   0.218  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5299.44 kN.
          -. Vuz    =        112.40 kN.
          -. Muy    =       -128.14 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.06 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.90

          -. Vuy    =        254.16 kN.
          -. Muz    =       -297.35 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.32 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.81
```

( ). Compute shear strength of concrete.
-. Vuz = 112.40 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1309.19 kN.
-. phiVcz = phi * Vcz = 1178.27 kN.

-. Vuy = 254.16 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1267.34 kN.
-. phiVcy = phi * Vcy = 1140.61 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2159.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5839.29 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2159.67 kN.
-. phiVsz = phi*Vsz = 1943.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2138.43 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5881.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2138.43 kN.
-. phiVsy = phi*Vsy = 1924.59 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 277.908 kN.
-. Vr = 3065.195 kN.
-. Ratio = Vu / Vr = 0.091 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 308.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 308.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0069 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0069 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0069 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117123,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5332.77       -71.94       -31.90      -170.27       -77.09
           ------------------------------------------------------------------------------
            DL+LL+Others     5332.77       -71.94       -31.90      -170.27       -77.09
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       31.90 kN-m.
           -. End Moments (My2) =       71.94 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -31.90 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -31.90 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       77.09 kN-m.
          -. End Moments (Mz2) =      170.27 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -77.09 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -77.09 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       146.427 kN-m.
          -. Mrz        =       352.623 kN-m.
          -. Mr         =       381.817 kN-m.
          -. Pu/Pr      =   0.219  --->  O.K !
          -. Muy/Mry    =   0.218  --->  O.K !
          -. Muz/Mrz    =   0.219  --->  O.K !
          -. Mu/Mr      =   0.219  --->  O.K !
          -. Ratio      =   0.219  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5316.12 kN.
          -. Vuz    =         80.09 kN.
          -. Muy    =        -71.94 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.98

          -. Vuy    =        186.36 kN.
          -. Muz    =       -170.27 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.09 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.89
```

( ). Compute shear strength of concrete.
-. Vuz = 80.09 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1345.94 kN.
-. phiVcz = phi * Vcz = 1211.35 kN.

-. Vuy = 186.36 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1304.70 kN.
-. phiVcy = phi * Vcy = 1174.23 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2177.46 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5802.54 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2177.46 kN.
-. phiVsz = phi*Vsz = 1959.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2157.44 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5843.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2157.44 kN.
-. phiVsy = phi*Vsy = 1941.70 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 202.841 kN.
-. Vr = 3115.926 kN.
-. Ratio = Vu / Vr = 0.065 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 225.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 225.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0076 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0076 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0076 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117124,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5349.44       -31.90        -7.96       -77.09       -19.73
           ------------------------------------------------------------------------------
            DL+LL+Others     5349.44       -31.90        -7.96       -77.09       -19.73
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.96 kN-m.
           -. End Moments (My2) =       31.90 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.96 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.96 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       19.73 kN-m.
          -. End Moments (Mz2) =       77.09 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -19.73 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -19.73 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        36.381 kN-m.
          -. Mrz        =        89.987 kN-m.
          -. Mr         =        97.063 kN-m.
          -. Pu/Pr      =   0.219  --->  O.K !
          -. Muy/Mry    =   0.219  --->  O.K !
          -. Muz/Mrz    =   0.219  --->  O.K !
          -. Mu/Mr      =   0.219  --->  O.K !
          -. Ratio      =   0.219  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5349.44 kN.
          -. Vuz    =         47.90 kN.
          -. Muy    =         -7.96 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        114.72 kN.
          -. Muz    =        -19.73 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 47.90 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1371.58 kN.
-. phiVcz = phi * Vcz = 1234.42 kN.

-. Vuy = 114.72 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1330.82 kN.
-. phiVcy = phi * Vcy = 1197.74 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2189.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5776.91 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2189.42 kN.
-. phiVsz = phi*Vsz = 1970.48 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2170.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5817.67 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2170.23 kN.
-. phiVsy = phi*Vsy = 1953.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 124.318 kN.
-. Vr = 3150.943 kN.
-. Ratio = Vu / Vr = 0.039 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 138.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 138.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0083 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0083 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0083 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117125,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5366.10        -7.96         0.00       -19.73         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5366.10        -7.96         0.00       -19.73         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        7.96 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =       19.73 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.220  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.220  --->  O.K !
          -. Ratio      =   0.220  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5366.10 kN.
          -. Vuz    =         15.91 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =         39.47 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01
```

( ). Compute shear strength of concrete.
-. Vuz = 15.91 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1358.68 kN.
-. phiVcz = phi * Vcz = 1222.81 kN.

-. Vuy = 39.47 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1358.68 kN.
-. phiVcy = phi * Vcy = 1222.81 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2183.45 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5789.80 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2183.45 kN.
-. phiVsz = phi*Vsz = 1965.10 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2183.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5789.80 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2183.45 kN.
-. phiVsy = phi*Vsy = 1965.10 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 42.552 kN.
-. Vr = 3187.917 kN.
-. Ratio = Vu / Vr = 0.013 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 47.28 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 47.28 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0086 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0086 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0086 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117202,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1560.41      1151.02      1282.88        19.40       581.29
           ---------------------------------------------------------------------------
           DL+LL+Others    -1560.41      1151.02      1282.88        19.40       581.29
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4848.729 kN.
          -. Mry        =      3570.039 kN-m.
          -. Mrz        =        49.584 kN-m.
          -. Mr         =      3570.384 kN-m.
          -. Pu/Pr      =   0.322  --->  O.K !
          -. Muy/Mry    =   0.322  --->  O.K !
          -. Muz/Mrz    =   0.391  --->  O.K !
          -. Mu/Mr      =   0.391  --->  O.K !
          -. Ratio      =   0.391  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4979.59 kN.
          -. Vuz    =        466.63 kN.
          -. Muy    =      -1301.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.21 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.27
```

-. Vuy = 1246.79 kN.
-. Muz = -846.73 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.65 Deg. [Clause 5.8.3.4.2]
-. betay = 2.17

( ). Compute shear strength of concrete.
-. Vuz = 466.63 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1024.47 kN.
-. phiVcz = phi * Vcz = 922.03 kN.

-. Vuy = 1246.79 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 981.33 kN.
-. phiVcy = phi * Vcy = 883.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1989.77 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6124.01 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1989.77 kN.
-. phiVsz = phi*Vsz = 1790.79 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1957.68 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6167.16 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1957.68 kN.
-. phiVsy = phi*Vsy = 1761.92 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1331.253 kN.
-. Vr = 2645.113 kN.
-. Ratio = Vu / Vr = 0.503 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1479.17 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1479.17 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117203,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -785.58      1665.04      1923.89       382.51       750.46
           ---------------------------------------------------------------------------
           DL+LL+Others     -785.58      1665.04      1923.89       382.51       750.46
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1723.839 kN.
          -. Mry        =      4184.488 kN-m.
          -. Mrz        =      1632.158 kN-m.
          -. Mr         =      4491.534 kN-m.
          -. Pu/Pr      =   0.456  --->  O.K !
          -. Muy/Mry    =   0.460  --->  O.K !
          -. Muz/Mrz    =   0.460  --->  O.K !
          -. Mu/Mr      =   0.460  --->  O.K !
          -. Ratio      =   0.460  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4996.40 kN.
          -. Vuz    =        402.56 kN.
          -. Muy    =      -1408.72 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.50 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
```

-. Vuy = 1109.73 kN.
-. Muz = -1346.63 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.96 Deg. [Clause 5.8.3.4.2]
-. betay = 2.11

( ). Compute shear strength of concrete.
-. Vuz = 402.56 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 994.96 kN.
-. phiVcz = phi * Vcz = 895.46 kN.

-. Vuy = 1109.73 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 952.02 kN.
-. phiVcy = phi * Vcy = 856.82 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1968.04 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6153.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1968.04 kN.
-. phiVsz = phi*Vsz = 1771.24 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1934.68 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6196.47 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1934.68 kN.
-. phiVsy = phi*Vsy = 1741.21 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 1180.492 kN.
-. Vr = 2598.028 kN.
-. Ratio = Vu / Vr = 0.454 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1311.66 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1311.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117204,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -773.70      1923.89      2117.88       750.46      1048.59
           ---------------------------------------------------------------------------
           DL+LL+Others     -773.70      1923.89      2117.88       750.46      1048.59
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -1492.094 kN.
          -. Mry        =      4089.193 kN-m.
          -. Mrz        =      2019.354 kN-m.
          -. Mr         =      4560.624 kN-m.
          -. Pu/Pr      =   0.519  --->  O.K !
          -. Muy/Mry    =   0.518  --->  O.K !
          -. Muz/Mrz    =   0.519  --->  O.K !
          -. Mu/Mr      =   0.519  --->  O.K !
          -. Ratio      =   0.519  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5013.22 kN.
          -. Vuz    =        308.20 kN.
          -. Muy    =      -1488.67 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.67 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.17
```

-. Vuy = 896.48 kN.
-. Muz = -1743.61 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 35.14 Deg. [Clause 5.8.3.4.2]
-. betay = 2.07

( ). Compute shear strength of concrete.
-. Vuz = 308.20 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 979.43 kN.
-. phiVcz = phi * Vcz = 881.49 kN.

-. Vuy = 896.48 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 936.63 kN.
-. phiVcy = phi * Vcy = 842.97 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz > phiVcz ---> Required shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy > phiVcy ---> Required shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1956.22 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6169.06 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1956.22 kN.
-. phiVsz = phi*Vsz = 1760.60 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1922.17 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6211.86 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1922.17 kN.
-. phiVsy = phi*Vsy = 1729.95 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 947.979 kN.
-. Vr = 2572.917 kN.
-. Ratio = Vu / Vr = 0.368 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 1053.31 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 1053.31 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0009 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0009 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0009 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117205,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1512.91      1492.94      1544.65      1543.95      1864.70
           ------------------------------------------------------------------------------
           DL+LL+Others    -1512.91      1492.94      1544.65      1543.95      1864.70
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2658.907 kN.
          -. Mry        =      2702.084 kN-m.
          -. Mrz        =      3261.597 kN-m.
          -. Mr         =      4235.478 kN-m.
          -. Pu/Pr      =   0.569  --->  O.K !
          -. Muy/Mry    =   0.572  --->  O.K !
          -. Muz/Mrz    =   0.572  --->  O.K !
          -. Mu/Mr      =   0.572  --->  O.K !
          -. Ratio      =   0.572  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5030.02 kN.
          -. Vuz    =        220.55 kN.
          -. Muy    =      -1531.76 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.73 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.16
```

-. Vuy = 676.28 kN.
-. Muz = -2033.66 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 35.20 Deg. [Clause 5.8.3.4.2]
-. betay = 2.06

( ). Compute shear strength of concrete.
-. Vuz = 220.55 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 973.75 kN.
-. phiVcz = phi * Vcz = 876.37 kN.

-. Vuy = 676.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 931.00 kN.
-. phiVcy = phi * Vcy = 837.90 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 1951.83 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6174.74 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 1951.83 kN.
-. phiVsz = phi*Vsz = 1756.65 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1917.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6217.48 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1917.52 kN.
-. phiVsy = phi*Vsy = 1725.77 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 711.338 kN.
-. Vr = 2563.672 kN.
-. Ratio = Vu / Vr = 0.277 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 790.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 790.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117206,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1501.06      1544.65      1553.20      1864.70      2077.19
           ---------------------------------------------------------------------------
           DL+LL+Others    -1501.06      1544.65      1553.20      1864.70      2077.19
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2484.515 kN.
          -. Mry        =      2556.376 kN-m.
          -. Mrz        =      3440.696 kN-m.
          -. Mr         =      4286.426 kN-m.
          -. Pu/Pr      =   0.604  --->  O.K !
          -. Muy/Mry    =   0.608  --->  O.K !
          -. Muz/Mrz    =   0.604  --->  O.K !
          -. Mu/Mr      =   0.608  --->  O.K !
          -. Ratio      =   0.608  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5046.82 kN.
          -. Vuz    =        151.53 kN.
          -. Muy    =      -1533.73 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.68 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.16
```

```
          -. Vuy    =       456.74 kN.
          -. Muz    =     -2217.56 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.07

     ( ). Compute shear strength of concrete.
          -. Vuz       =     151.53 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     977.92 kN.
          -. phiVcz    = phi * Vcz =     880.13 kN.

          -. Vuy       =     456.74 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     935.13 kN.
          -. phiVcy    = phi * Vcy =     841.62 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1955.06 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6170.57 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1955.06 kN.
          -. phiVsz   = phi*Vsz =     1759.55 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1920.94 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6213.35 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1920.94 kN.
          -. phiVsy   = phi*Vsy =     1728.84 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     481.218 kN.
          -. Vr       =    2570.464 kN.
          -. Ratio    = Vu / Vr = 0.187  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 534.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 534.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117207,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1489.20      1553.20      1529.75      2077.19      2208.74
           ---------------------------------------------------------------------------
           DL+LL+Others    -1489.20      1553.20      1529.75      2077.19      2208.74
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2396.374 kN.
          -. Mry        =      2450.128 kN-m.
          -. Mrz        =      3554.426 kN-m.
          -. Mr         =      4317.068 kN-m.
          -. Pu/Pr      =   0.621  --->  O.K !
          -. Muy/Mry    =   0.624  --->  O.K !
          -. Muz/Mrz    =   0.621  --->  O.K !
          -. Mu/Mr      =   0.624  --->  O.K !
          -. Ratio      =   0.624  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5063.61 kN.
          -. Vuz    =        128.75 kN.
          -. Muy    =      -1505.27 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.62 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.18
```

```
          -. Vuy    =       292.33 kN.
          -. Muz    =     -2322.47 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  35.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.08

     ( ). Compute shear strength of concrete.
          -. Vuz       =     128.75 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     984.17 kN.
          -. phiVcz    = phi * Vcz =     885.75 kN.

          -. Vuy       =     292.33 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     941.32 kN.
          -. phiVcy    = phi * Vcy =     847.19 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1959.86 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6164.32 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1959.86 kN.
          -. phiVsz   = phi*Vsz =     1763.87 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1926.02 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6207.16 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1926.02 kN.
          -. phiVsy   = phi*Vsy =     1733.41 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     319.425 kN.
          -. Vr       =    2580.606 kN.
          -. Ratio    = Vu / Vr = 0.124  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 354.92 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 354.92 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
- As = 0.0363 m^2.
- As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117208,  LCB = 152+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1477.34      1529.75      1479.47      2208.74      2272.60
           ---------------------------------------------------------------------------
            DL+LL+Others    -1477.34      1529.75      1479.47      2208.74      2272.60
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2356.930 kN.
          -. Mry        =      2358.651 kN-m.
          -. Mrz        =      3628.334 kN-m.
          -. Mr         =      4327.591 kN-m.
          -. Pu/Pr      =   0.627  --->  O.K !
          -. Muy/Mry    =   0.627  --->  O.K !
          -. Muz/Mrz    =   0.626  --->  O.K !
          -. Mu/Mr      =   0.627  --->  O.K !
          -. Ratio      =   0.627  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5080.39 kN.
          -. Vuz    =        149.32 kN.
          -. Muy    =      -1451.32 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.20
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```
          -. Vuy    =       153.10 kN.
          -. Muz    =     -2361.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.99 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.10

     ( ). Compute shear strength of concrete.
          -. Vuz       =     149.32 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      992.41 kN.
          -. phiVcz    = phi * Vcz =      893.17 kN.

          -. Vuy       =     153.10 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      949.50 kN.
          -. phiVcy    = phi * Vcy =      854.55 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1966.12 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6156.07 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1966.12 kN.
          -. phiVsz   = phi*Vsz =     1769.51 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1932.65 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6198.99 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1932.65 kN.
          -. phiVsy   = phi*Vsy =     1739.38 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     213.854 kN.
          -. Vr       =    2593.932 kN.
          -. Ratio    = Vu / Vr = 0.082  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 237.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 237.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117209,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1477.46      1479.47      1407.96      2272.60      2279.26
           ---------------------------------------------------------------------------
           DL+LL+Others    -1477.46      1479.47      1407.96      2272.60      2279.26
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2356.930 kN.
          -. Mry        =      2358.651 kN-m.
          -. Mrz        =      3628.334 kN-m.
          -. Mr         =      4327.591 kN-m.
          -. Pu/Pr      =   0.627  --->  O.K !
          -. Muy/Mry    =   0.627  --->  O.K !
          -. Muz/Mrz    =   0.626  --->  O.K !
          -. Mu/Mr      =   0.627  --->  O.K !
          -. Ratio      =   0.627  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4329.29 kN.
          -. Vuz    =        206.19 kN.
          -. Muy    =      -2191.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.15 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.28
```

```
          -. Vuy    =         48.88 kN.
          -. Muz    =      -1649.78 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.58 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.19

     ( ). Compute shear strength of concrete.
          -. Vuz       =      206.19 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1030.98 kN.
          -. phiVcz    = phi * Vcz =      927.89 kN.

          -. Vuy       =       48.88 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      987.80 kN.
          -. phiVcy    = phi * Vcy =      889.02 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1994.43 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6117.50 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1994.43 kN.
          -. phiVsz   = phi*Vsz =     1794.99 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1962.63 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6160.68 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1962.63 kN.
          -. phiVsy   = phi*Vsy =     1766.37 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     211.899 kN.
          -. Vr       =    2655.390 kN.
          -. Ratio    = Vu / Vr = 0.080  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 235.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 235.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0020 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0020 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117210,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1465.58      1407.96      1323.34      2279.26      2248.43
           ---------------------------------------------------------------------------
           DL+LL+Others    -1465.58      1407.96      1323.34      2279.26      2248.43
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2356.986 kN.
          -. Mry        =      2276.871 kN-m.
          -. Mrz        =      3680.196 kN-m.
          -. Mr         =      4327.584 kN-m.
          -. Pu/Pr      =   0.622  --->  O.K !
          -. Muy/Mry    =   0.618  --->  O.K !
          -. Muz/Mrz    =   0.619  --->  O.K !
          -. Mu/Mr      =   0.622  --->  O.K !
          -. Ratio      =   0.622  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4346.03 kN.
          -. Vuz    =        246.46 kN.
          -. Muy    =      -2096.58 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.11 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.29
```

```
          -. Vuy    =         83.87 kN.
          -. Muz    =      -1633.97 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.20

     ( ). Compute shear strength of concrete.
          -. Vuz       =      246.46 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1035.02 kN.
          -. phiVcz    = phi * Vcz =      931.52 kN.

          -. Vuy       =       83.87 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      991.82 kN.
          -. phiVcy    = phi * Vcy =      892.63 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1997.30 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6113.47 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1997.30 kN.
          -. phiVsz   = phi*Vsz =     1797.57 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1965.67 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6156.67 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1965.67 kN.
          -. phiVsy   = phi*Vsy =     1769.10 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     260.335 kN.
          -. Vr       =    2661.738 kN.
          -. Ratio    = Vu / Vr = 0.098  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 289.26 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 289.26 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0018 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0018 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0018 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117211,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1453.70      1323.34      1229.39      2248.43      2188.40
           ---------------------------------------------------------------------------
           DL+LL+Others    -1453.70      1323.34      1229.39      2248.43      2188.40
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2394.298 kN.
          -. Mry        =      2196.724 kN-m.
          -. Mrz        =      3716.647 kN-m.
          -. Mr         =      4317.298 kN-m.
          -. Pu/Pr      =   0.607  --->  O.K !
          -. Muy/Mry    =   0.602  --->  O.K !
          -. Muz/Mrz    =   0.605  --->  O.K !
          -. Mu/Mr      =   0.607  --->  O.K !
          -. Ratio      =   0.607  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4362.77 kN.
          -. Vuz    =        276.57 kN.
          -. Muy    =      -1979.70 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.31
```

-. Vuy = 120.44 kN.
-. Muz = -1593.67 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.45 Deg. [Clause 5.8.3.4.2]
-. betay = 2.21

( ). Compute shear strength of concrete.
-. Vuz = 276.57 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1043.46 kN.
-. phiVcz = phi * Vcz = 939.12 kN.

-. Vuy = 120.44 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1000.22 kN.
-. phiVcy = phi * Vcy = 900.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2003.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6105.02 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2003.26 kN.
-. phiVsz = phi*Vsz = 1802.93 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1971.98 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6148.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1971.98 kN.
-. phiVsy = phi*Vsy = 1774.79 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 301.656 kN.
-. Vr = 2674.983 kN.
-. Ratio = Vu / Vr = 0.113 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 335.17 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 335.17 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0015 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117212,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1441.80      1229.39      1129.44      2188.40      2107.69
           ---------------------------------------------------------------------------
           DL+LL+Others    -1441.80      1229.39      1129.44      2188.40      2107.69
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2465.717 kN.
          -. Mry        =      2113.626 kN-m.
          -. Mrz        =      3741.094 kN-m.
          -. Mr         =      4296.883 kN-m.
          -. Pu/Pr      =   0.585  --->  O.K !
          -. Muy/Mry    =   0.582  --->  O.K !
          -. Muz/Mrz    =   0.585  --->  O.K !
          -. Mu/Mr      =   0.585  --->  O.K !
          -. Ratio      =   0.585  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4379.50 kN.
          -. Vuz    =        297.45 kN.
          -. Muy    =      -1846.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.92 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.34
```

```
          -. Vuy    =       147.84 kN.
          -. Muz    =     -1534.51 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.33 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.24

     ( ). Compute shear strength of concrete.
          -. Vuz       =     297.45 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1055.97 kN.
          -. phiVcz    = phi * Vcz =      950.37 kN.

          -. Vuy       =     147.84 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1012.67 kN.
          -. phiVcy    = phi * Vcy =      911.40 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2011.94 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6092.52 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2011.94 kN.
          -. phiVsz   = phi*Vsz =     1810.74 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1981.19 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6135.82 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1981.19 kN.
          -. phiVsy   = phi*Vsy =     1783.07 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     332.169 kN.
          -. Vr       =    2694.475 kN.
          -. Ratio    = Vu / Vr = 0.123  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 369.08 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 369.08 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117213,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1429.90      1129.44      1008.76      2107.69      1957.76
           ---------------------------------------------------------------------------
           DL+LL+Others    -1429.90      1129.44      1008.76      2107.69      1957.76
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2565.830 kN.
          -. Mry        =      2021.623 kN-m.
          -. Mrz        =      3757.253 kN-m.
          -. Mr         =      4266.604 kN-m.
          -. Pu/Pr      =   0.557  --->  O.K !
          -. Muy/Mry    =   0.559  --->  O.K !
          -. Muz/Mrz    =   0.561  --->  O.K !
          -. Mu/Mr      =   0.561  --->  O.K !
          -. Ratio      =   0.561  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       4396.23 kN.
          -. Vuz    =        361.16 kN.
          -. Muy    =      -1702.18 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.35
```

```
          -. Vuy    =       236.57 kN.
          -. Muz    =     -1462.60 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.25 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.26

     ( ). Compute shear strength of concrete.
          -. Vuz       =     361.16 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1063.52 kN.
          -. phiVcz    = phi * Vcz =      957.17 kN.

          -. Vuy       =     236.57 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1020.20 kN.
          -. phiVcy    = phi * Vcy =      918.18 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2017.11 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6084.97 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2017.11 kN.
          -. phiVsz   = phi*Vsz =     1815.40 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1986.68 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6128.29 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1986.68 kN.
          -. phiVsy   = phi*Vsy =     1788.01 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     431.745 kN.
          -. Vr       =    2706.188 kN.
          -. Ratio    = Vu / Vr = 0.160  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 479.72 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 479.72 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117214,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1417.99      1008.76       877.37      1957.76      1760.75
           ---------------------------------------------------------------------------
           DL+LL+Others    -1417.99      1008.76       877.37      1957.76      1760.75
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2739.229 kN.
          -. Mry        =      1941.856 kN-m.
          -. Mrz        =      3740.967 kN-m.
          -. Mr         =      4214.931 kN-m.
          -. Pu/Pr      =   0.518  --->  O.K !
          -. Muy/Mry    =   0.519  --->  O.K !
          -. Muz/Mrz    =   0.523  --->  O.K !
          -. Mu/Mr      =   0.523  --->  O.K !
          -. Ratio      =   0.523  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5164.29 kN.
          -. Vuz    =        262.99 kN.
          -. Muy    =       -975.91 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  34.20 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.27
```

```
          -. Vuy    =       418.78 kN.
          -. Muz    =     -1951.77 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.63 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.18

     ( ). Compute shear strength of concrete.
          -. Vuz       =      262.99 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1026.02 kN.
          -. phiVcz    = phi * Vcz =      923.42 kN.

          -. Vuy       =      418.78 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      982.87 kN.
          -. phiVcy    = phi * Vcy =      884.58 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     1990.88 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6122.47 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     1990.88 kN.
          -. phiVsz   = phi*Vsz =     1791.79 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1958.86 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6165.62 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1958.86 kN.
          -. phiVsy   = phi*Vsy =     1762.98 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     494.513 kN.
          -. Vr       =    2647.558 kN.
          -. Ratio    = Vu / Vr = 0.187  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 549.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 549.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0006 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0006 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0006 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117215,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1406.08       877.37       743.22      1760.75      1535.85
           ---------------------------------------------------------------------------
           DL+LL+Others    -1406.08       877.37       743.22      1760.75      1535.85
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -2969.530 kN.
          -. Mry        =      1853.526 kN-m.
          -. Mrz        =      3715.954 kN-m.
          -. Mr         =      4152.574 kN-m.
          -. Pu/Pr      =   0.474  --->  O.K !
          -. Muy/Mry    =   0.473  --->  O.K !
          -. Muz/Mrz    =   0.474  --->  O.K !
          -. Mu/Mr      =   0.474  --->  O.K !
          -. Ratio      =   0.474  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5181.02 kN.
          -. Vuz    =        264.91 kN.
          -. Muy    =       -846.90 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.32
```

```
          -. Vuy    =       464.71 kN.
          -. Muz    =     -1745.92 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  34.40 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.23

     ( ). Compute shear strength of concrete.
          -. Vuz       =      264.91 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1048.80 kN.
          -. phiVcz    = phi * Vcz =      943.92 kN.

          -. Vuy       =      464.71 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1005.53 kN.
          -. phiVcy    = phi * Vcy =      904.98 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.449 m.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.449 m.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2006.98 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     6099.69 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2006.98 kN.
          -. phiVsz   = phi*Vsz =     1806.28 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     1975.93 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6142.95 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     1975.93 kN.
          -. phiVsy   = phi*Vsy =     1778.34 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     534.913 kN.
          -. Vr       =    2683.318 kN.
          -. Ratio    = Vu / Vr = 0.199  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 594.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 594.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0013 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0013 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0013 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117216,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1394.16       743.22       612.40      1535.85      1299.09
           ---------------------------------------------------------------------------
           DL+LL+Others    -1394.16       743.22       612.40      1535.85      1299.09
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3306.523 kN.
          -. Mry        =      1761.741 kN-m.
          -. Mrz        =      3654.231 kN-m.
          -. Mr         =      4056.740 kN-m.
          -. Pu/Pr      =   0.422  --->  O.K !
          -. Muy/Mry    =   0.422  --->  O.K !
          -. Muz/Mrz    =   0.420  --->  O.K !
          -. Mu/Mr      =   0.422  --->  O.K !
          -. Ratio      =   0.422  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5197.75 kN.
          -. Vuz    =        256.19 kN.
          -. Muy    =       -715.96 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.39
```

-. Vuy = 479.81 kN.
-. Muz = -1515.83 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 34.11 Deg. [Clause 5.8.3.4.2]
-. betay = 2.29

( ). Compute shear strength of concrete.
-. Vuz = 256.19 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1078.69 kN.
-. phiVcz = phi * Vcz = 970.82 kN.

-. Vuy = 479.81 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1035.33 kN.
-. phiVcy = phi * Vcy = 931.80 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2027.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6069.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2027.33 kN.
-. phiVsz = phi*Vsz = 1824.60 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 1997.52 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6113.15 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 1997.52 kN.
-. phiVsy = phi*Vsy = 1797.77 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 543.918 kN.
-. Vr = 2729.569 kN.
-. Ratio = Vu / Vr = 0.199 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 604.35 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 604.35 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117217,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1382.23       612.40       489.37      1299.09      1063.26
           ---------------------------------------------------------------------------
           DL+LL+Others    -1382.23       612.40       489.37      1299.09      1063.26
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -3775.919 kN.
          -. Mry        =      1667.078 kN-m.
          -. Mrz        =      3536.829 kN-m.
          -. Mr         =      3910.027 kN-m.
          -. Pu/Pr      =   0.366  --->  O.K !
          -. Muy/Mry    =   0.367  --->  O.K !
          -. Muz/Mrz    =   0.367  --->  O.K !
          -. Mu/Mr      =   0.367  --->  O.K !
          -. Ratio      =   0.367  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5214.47 kN.
          -. Vuz    =        239.51 kN.
          -. Muy    =       -588.83 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.42 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.47
```

-. Vuy = 471.83 kN.
-. Muz = -1276.84 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.79 Deg. [Clause 5.8.3.4.2]
-. betay = 2.37

( ). Compute shear strength of concrete.
-. Vuz = 239.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1113.86 kN.
-. phiVcz = phi * Vcz = 1002.47 kN.

-. Vuy = 471.83 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1070.47 kN.
-. phiVcy = phi * Vcy = 963.43 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.449 m.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.449 m.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2050.21 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 6034.63 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2050.21 kN.
-. phiVsz = phi*Vsz = 1845.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2021.82 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 6078.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2021.82 kN.
-. phiVsy = phi*Vsy = 1819.64 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 529.138 kN.
-. Vr = 2783.062 kN.
-. Ratio = Vu / Vr = 0.190 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 587.93 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 587.93 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0030 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0030 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0030 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117218,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)            -                           -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1370.29       489.37       377.30      1063.26       838.21
           ---------------------------------------------------------------------------
           DL+LL+Others    -1370.29       489.37       377.30      1063.26       838.21
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -4374.513 kN.
          -. Mry        =      1553.662 kN-m.
          -. Mrz        =      3374.323 kN-m.
          -. Mr         =      3714.825 kN-m.
          -. Pu/Pr      =   0.313  --->  O.K !
          -. Muy/Mry    =   0.315  --->  O.K !
          -. Muz/Mrz    =   0.315  --->  O.K !
          -. Mu/Mr      =   0.315  --->  O.K !
          -. Ratio      =   0.315  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5231.18 kN.
          -. Vuz    =        217.20 kN.
          -. Muy    =       -469.71 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  33.11 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.55
```

```
          -. Vuy    =        446.55 kN.
          -. Muz    =      -1041.09 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  33.46 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.46

     ( ). Compute shear strength of concrete.
          -. Vuz       =      217.20 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1152.66 kN.
          -. phiVcz    = phi * Vcz =     1037.39 kN.

          -. Vuy       =      446.55 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1109.35 kN.
          -. phiVcy    = phi * Vcy =      998.41 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.610 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.150 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.610 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.150 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.150 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =     2074.21 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     5995.83 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =     2074.21 kN.
          -. phiVsz   = phi*Vsz =     1866.78 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0038 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =     2047.33 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     6039.14 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =     2047.33 kN.
          -. phiVsy   = phi*Vsy =     1842.60 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0038 m^2/m.

          -. Vu       =     496.568 kN.
          -. Vr       =    2841.014 kN.
          -. Ratio    = Vu / Vr = 0.175  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 551.74 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 551.74 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117219,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others          -1358.35       377.30       278.30       838.21       631.36
           ------------------------------------------------------------------------------
            DL+LL+Others    -1358.35       377.30       278.30       838.21       631.36
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     -5137.495 kN.
          -. Mry        =      1418.303 kN-m.
          -. Mrz        =      3159.866 kN-m.
          -. Mr         =      3463.573 kN-m.
          -. Pu/Pr      =   0.264  --->  O.K !
          -. Muy/Mry    =   0.266  --->  O.K !
          -. Muz/Mrz    =   0.265  --->  O.K !
          -. Mu/Mr      =   0.266  --->  O.K !
          -. Ratio      =   0.266  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5247.88 kN.
          -. Vuz    =        191.14 kN.
          -. Muy    =       -361.52 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.81 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.64
```

-. Vuy = 407.77 kN.
-. Muz = -817.83 kN-m.
-. bvy = 1.20 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.86 m.
-. thetay = 33.13 Deg. [Clause 5.8.3.4.2]
-. betay = 2.55

( ). Compute shear strength of concrete.
-. Vuz = 191.14 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1193.63 kN.
-. phiVcz = phi * Vcz = 1074.26 kN.

-. Vuy = 407.77 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1150.52 kN.
-. phiVcy = phi * Vcy = 1035.47 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2098.24 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5954.86 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2098.24 kN.
-. phiVsz = phi*Vsz = 1888.42 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2072.92 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5997.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2072.92 kN.
-. phiVsy = phi*Vsy = 1865.63 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 450.342 kN.
-. Vr = 2901.096 kN.
-. Ratio = Vu / Vr = 0.155 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 500.38 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 500.38 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0048 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0047 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0047 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117220,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5264.58      -266.21      -184.92      -613.95      -434.41
           ------------------------------------------------------------------------------
            DL+LL+Others     5264.58      -266.21      -184.92      -613.95      -434.41
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      184.92 kN-m.
           -. End Moments (My2) =      266.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -266.21 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -266.21 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      434.41 kN-m.
          -. End Moments (Mz2) =      613.95 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -613.95 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -613.95 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     22311.094 kN.
          -. Mry        =      1123.355 kN-m.
          -. Mrz        =      2592.206 kN-m.
          -. Mr         =      2825.147 kN-m.
          -. Pu/Pr      =   0.236  --->  O.K !
          -. Muy/Mry    =   0.237  --->  O.K !
          -. Muz/Mrz    =   0.237  --->  O.K !
          -. Mu/Mr      =   0.237  --->  O.K !
          -. Ratio      =   0.237  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5264.58 kN.
          -. Vuz    =        162.88 kN.
          -. Muy    =       -266.21 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.53 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.73

          -. Vuy    =        359.07 kN.
          -. Muz    =       -613.95 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64
```

( ). Compute shear strength of concrete.
-. Vuz = 162.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1235.27 kN.
-. phiVcz = phi * Vcz = 1111.74 kN.

-. Vuy = 359.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1192.50 kN.
-. phiVcy = phi * Vcy = 1073.25 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2121.40 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5913.22 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2121.40 kN.
-. phiVsz = phi*Vsz = 1909.26 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2097.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5955.99 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2097.60 kN.
-. phiVsy = phi*Vsy = 1887.84 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 394.291 kN.
-. Vr = 2961.086 kN.
-. Ratio = Vu / Vr = 0.133 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 438.10 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 438.10 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0056 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0056 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0056 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117221,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5281.27      -184.92      -118.26      -434.41      -282.79
           ------------------------------------------------------------------------------
            DL+LL+Others     5281.27      -184.92      -118.26      -434.41      -282.79
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =      118.26 kN-m.
           -. End Moments (My2) =      184.92 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -184.92 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -184.92 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      282.79 kN-m.
          -. End Moments (Mz2) =      434.41 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -434.41 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -434.41 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24384.903 kN.
          -. Mry        =       850.536 kN-m.
          -. Mrz        =      2003.552 kN-m.
          -. Mr         =      2176.610 kN-m.
          -. Pu/Pr      =   0.217  --->  O.K !
          -. Muy/Mry    =   0.217  --->  O.K !
          -. Muz/Mrz    =   0.217  --->  O.K !
          -. Mu/Mr      =   0.217  --->  O.K !
          -. Ratio      =   0.217  --->  O.K !

 ========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ========================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5281.27 kN.
          -. Vuz    =        133.51 kN.
          -. Muy    =       -184.92 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.82

          -. Vuy    =        303.24 kN.
          -. Muz    =       -434.41 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.73
```

( ). Compute shear strength of concrete.
-. Vuz = 133.51 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1276.11 kN.
-. phiVcz = phi * Vcz = 1148.50 kN.

-. Vuy = 303.24 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1233.80 kN.
-. phiVcy = phi * Vcy = 1110.42 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2142.97 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5872.38 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2142.97 kN.
-. phiVsz = phi*Vsz = 1928.67 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2120.60 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5914.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2120.60 kN.
-. phiVsy = phi*Vsy = 1908.54 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 331.331 kN.
-. Vr = 3018.962 kN.
-. Ratio = Vu / Vr = 0.110 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 368.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 368.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0063 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0063 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0063 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117222,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5314.61      -118.26       -66.44      -282.79      -161.69
           ---------------------------------------------------------------------------
            DL+LL+Others     5314.61      -118.26       -66.44      -282.79      -161.69
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       66.44 kN-m.
           -. End Moments (My2) =      118.26 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -66.44 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -66.44 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      161.69 kN-m.
          -. End Moments (Mz2) =      282.79 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -161.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -161.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       305.973 kN-m.
          -. Mrz        =       742.116 kN-m.
          -. Mr         =       802.718 kN-m.
          -. Pu/Pr      =   0.218  --->  O.K !
          -. Muy/Mry    =   0.217  --->  O.K !
          -. Muz/Mrz    =   0.218  --->  O.K !
          -. Mu/Mr      =   0.218  --->  O.K !
          -. Ratio      =   0.218  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5297.96 kN.
          -. Vuz    =        103.72 kN.
          -. Muy    =       -118.26 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  32.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.91

          -. Vuy    =        242.21 kN.
          -. Muz    =       -282.79 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.28 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.82
```

( ). Compute shear strength of concrete.
-. Vuz = 103.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1314.74 kN.
-. phiVcz = phi * Vcz = 1183.26 kN.

-. Vuy = 242.21 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1272.97 kN.
-. phiVcy = phi * Vcy = 1145.67 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2162.40 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5833.75 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2162.40 kN.
-. phiVsz = phi*Vsz = 1946.16 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2141.35 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5875.52 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2141.35 kN.
-. phiVsy = phi*Vsy = 1927.22 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 263.484 kN.
-. Vr = 3072.890 kN.
-. Ratio = Vu / Vr = 0.086 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 292.76 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 292.76 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0070 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0070 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0070 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117223,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5331.29       -66.44       -29.50      -161.69       -73.09
           ------------------------------------------------------------------------------
            DL+LL+Others     5331.29       -66.44       -29.50      -161.69       -73.09
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       29.50 kN-m.
           -. End Moments (My2) =       66.44 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -29.50 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -29.50 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       73.09 kN-m.
          -. End Moments (Mz2) =      161.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -73.09 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -73.09 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =       135.381 kN-m.
          -. Mrz        =       334.442 kN-m.
          -. Mr         =       360.804 kN-m.
          -. Pu/Pr      =   0.218  --->  O.K !
          -. Muy/Mry    =   0.218  --->  O.K !
          -. Muz/Mrz    =   0.219  --->  O.K !
          -. Mu/Mr      =   0.219  --->  O.K !
          -. Ratio      =   0.219  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5314.63 kN.
          -. Vuz    =         73.92 kN.
          -. Muy    =        -66.44 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.99

          -. Vuy    =        177.20 kN.
          -. Muz    =       -161.69 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  32.07 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.90
```

( ). Compute shear strength of concrete.
-. Vuz = 73.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1349.81 kN.
-. phiVcz = phi * Vcz = 1214.83 kN.

-. Vuy = 177.20 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1308.63 kN.
-. phiVcy = phi * Vcy = 1177.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2179.28 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5798.68 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2179.28 kN.
-. phiVsz = phi*Vsz = 1961.36 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2159.39 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5839.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2159.39 kN.
-. phiVsy = phi*Vsy = 1943.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 191.998 kN.
-. Vr = 3121.223 kN.
-. Ratio = Vu / Vr = 0.062 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 213.33 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 213.33 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0076 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0076 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0076 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117224,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5347.96       -29.50        -7.38       -73.09       -18.67
           ------------------------------------------------------------------------------
            DL+LL+Others     5347.96       -29.50        -7.38       -73.09       -18.67
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.38 kN-m.
           -. End Moments (My2) =       29.50 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       18.67 kN-m.
          -. End Moments (Mz2) =       73.09 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -18.67 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -18.67 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =        33.722 kN-m.
          -. Mrz        =        85.173 kN-m.
          -. Mr         =        91.606 kN-m.
          -. Pu/Pr      =   0.219  --->  O.K !
          -. Muy/Mry    =   0.219  --->  O.K !
          -. Muz/Mrz    =   0.219  --->  O.K !
          -. Mu/Mr      =   0.219  --->  O.K !
          -. Ratio      =   0.219  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5347.96 kN.
          -. Vuz    =         44.27 kN.
          -. Muy    =         -7.38 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.04

          -. Vuy    =        108.84 kN.
          -. Muz    =        -18.67 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95
```

( ). Compute shear strength of concrete.
-. Vuz = 44.27 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1374.06 kN.
-. phiVcz = phi * Vcz = 1236.65 kN.

-. Vuy = 108.84 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1333.35 kN.
-. phiVcy = phi * Vcy = 1200.02 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2190.56 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5774.43 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2190.56 kN.
-. phiVsz = phi*Vsz = 1971.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2171.45 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5815.13 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2171.45 kN.
-. phiVsy = phi*Vsy = 1954.31 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 117.495 kN.
-. Vr = 3154.322 kN.
-. Ratio = Vu / Vr = 0.037 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 130.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 130.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0083 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0083 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0083 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =117225,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    64) : Pilote_1.20
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.200 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         25-#14 (    0.0363)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#6  @150

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           5364.62        -7.38         0.00       -18.67         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     5364.62        -7.38         0.00       -18.67         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        7.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.300 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    1.667  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =       18.67 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.300 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    1.667  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0321
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     24404.708 kN.
          -. Pr         =     24404.708 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.220  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.220  --->  O.K !
          -. Ratio      =   0.220  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0006 m^2.
          -. Pu     =       5364.62 kN.
          -. Vuz    =         14.75 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.20 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.86 m.
          -. thetaz =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.01

          -. Vuy    =         37.34 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.20 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.86 m.
          -. thetay =  31.78 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.01
```

( ). Compute shear strength of concrete.
-. Vuz = 14.75 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1359.70 kN.
-. phiVcz = phi * Vcz = 1223.73 kN.

-. Vuy = 37.34 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1359.70 kN.
-. phiVcy = phi * Vcy = 1223.73 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.610 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.150 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.610 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.150 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.150 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 2183.92 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 5788.79 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 2183.92 kN.
-. phiVsz = phi*Vsz = 1965.53 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0038 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 2183.92 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 5788.79 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 2183.92 kN.
-. phiVsy = phi*Vsy = 1965.53 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0038 m^2/m.

-. Vu = 40.148 kN.
-. Vr = 3189.260 kN.
-. Ratio = Vu / Vr = 0.013 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 44.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 44.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0086 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0086 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0086 m^2.
-. As = 0.0363 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121002,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -921.81       507.76       575.02       948.03       791.36
           ------------------------------------------------------------------------------
            DL+LL+Others     -921.81       507.76       575.02       948.03       791.36
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2046.019 kN.
          -. Mry        =      1126.886 kN-m.
          -. Mrz        =      2119.711 kN-m.
          -. Mr         =      2400.635 kN-m.
          -. Pu/Pr      =   0.451  --->  O.K !
          -. Muy/Mry    =   0.451  --->  O.K !
          -. Muz/Mrz    =   0.447  --->  O.K !
          -. Mu/Mr      =   0.451  --->  O.K !
          -. Ratio      =   0.451  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1653.33 kN.
          -. Vuz    =        486.21 kN.
          -. Muy    =       -774.68 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.60 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71
```

```
          -. Vuy    =       180.03 kN.
          -. Muz    =      -573.61 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.05 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.57

     ( ). Compute shear strength of concrete.
          -. Vuz       =     486.21 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     850.54 kN.
          -. phiVcz    = phi * Vcz =     765.48 kN.

          -. Vuy       =     180.03 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     806.65 kN.
          -. phiVcy    = phi * Vcy =     725.99 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      601.05 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4113.69 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      601.05 kN.
          -. phiVsz   = phi*Vsz =      540.94 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      590.78 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4157.57 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      590.78 kN.
          -. phiVsy   = phi*Vsy =      531.70 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     518.470 kN.
          -. Vr       =    1257.691 kN.
          -. Ratio    = Vu / Vr = 0.412  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 576.08 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 576.08 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0020 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0020 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0020 m^2.
- As = 0.0261 m^2.
- As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121003,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -913.76       575.02       644.77       791.36       645.63
           ------------------------------------------------------------------------------
            DL+LL+Others     -913.76       575.02       644.77       791.36       645.63
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2215.920 kN.
          -. Mry        =      1396.607 kN-m.
          -. Mrz        =      1904.156 kN-m.
          -. Mr         =      2361.424 kN-m.
          -. Pu/Pr      =   0.412  --->  O.K !
          -. Muy/Mry    =   0.412  --->  O.K !
          -. Muz/Mrz    =   0.416  --->  O.K !
          -. Mu/Mr      =   0.416  --->  O.K !
          -. Ratio      =   0.416  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2162.19 kN.
          -. Vuz    =        283.70 kN.
          -. Muy    =       -609.67 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.61
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```
          -. Vuy    =       323.03 kN.
          -. Muz    =      -805.15 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.39 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.47

     ( ). Compute shear strength of concrete.
          -. Vuz       =      283.70 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      819.98 kN.
          -. phiVcz    = phi * Vcz =      737.98 kN.

          -. Vuy       =      323.03 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      775.81 kN.
          -. phiVcy    = phi * Vcy =      698.23 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      593.99 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4144.24 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      593.99 kN.
          -. phiVsz   = phi*Vsz =      534.59 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      583.04 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4188.42 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      583.04 kN.
          -. phiVsy   = phi*Vsy =      524.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     429.925 kN.
          -. Vr       =    1222.965 kN.
          -. Ratio    = Vu / Vr = 0.352  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 477.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 477.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121004,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -388.50       911.04      1050.48       509.29       461.64
           ------------------------------------------------------------------------------
            DL+LL+Others     -388.50       911.04      1050.48       509.29       461.64
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -886.917 kN.
          -. Mry        =      2425.567 kN-m.
          -. Mrz        =      1054.928 kN-m.
          -. Mr         =      2645.043 kN-m.
          -. Pu/Pr      =   0.438  --->  O.K !
          -. Muy/Mry    =   0.433  --->  O.K !
          -. Muz/Mrz    =   0.438  --->  O.K !
          -. Mu/Mr      =   0.438  --->  O.K !
          -. Ratio      =   0.438  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2174.02 kN.
          -. Vuz    =        235.69 kN.
          -. Muy    =       -669.65 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.67
```

-. Vuy = 299.43 kN.
-. Muz = -656.23 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 33.18 Deg. [Clause 5.8.3.4.2]
-. betay = 2.53

( ). Compute shear strength of concrete.
-. Vuz = 235.69 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 838.79 kN.
-. phiVcz = phi * Vcz = 754.91 kN.

-. Vuy = 299.43 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 794.78 kN.
-. phiVcy = phi * Vcy = 715.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.245 m.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.245 m.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 598.38 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 4125.44 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 598.38 kN.
-. phiVsz = phi*Vsz = 538.54 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 587.86 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4169.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 587.86 kN.
-. phiVsy = phi*Vsy = 529.07 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 381.059 kN.
-. Vr = 1244.371 kN.
-. Ratio = Vu / Vr = 0.306 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 423.40 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 423.40 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121005,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -380.29      1050.48      1157.34       461.64       417.19
           ---------------------------------------------------------------------------
           DL+LL+Others     -380.29      1050.48      1157.34       461.64       417.19
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -822.063 kN.
          -. Mry        =      2497.551 kN-m.
          -. Mrz        =       900.497 kN-m.
          -. Mr         =      2654.931 kN-m.
          -. Pu/Pr      =   0.463  --->  O.K !
          -. Muy/Mry    =   0.463  --->  O.K !
          -. Muz/Mrz    =   0.463  --->  O.K !
          -. Mu/Mr      =   0.463  --->  O.K !
          -. Ratio      =   0.463  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2185.84 kN.
          -. Vuz    =        190.73 kN.
          -. Muy    =       -724.18 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.57 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.72
```

```
          -. Vuy    =       275.30 kN.
          -. Muz    =      -519.67 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.58

     ( ). Compute shear strength of concrete.
          -. Vuz       =     190.73 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     853.04 kN.
          -. phiVcz    = phi * Vcz =     767.74 kN.

          -. Vuy       =     275.30 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     809.19 kN.
          -. phiVcy    = phi * Vcy =     728.27 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      601.61 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4111.19 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      601.61 kN.
          -. phiVsz   = phi*Vsz =      541.45 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      591.40 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4155.04 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      591.40 kN.
          -. phiVsy   = phi*Vsy =      532.26 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     334.915 kN.
          -. Vr       =    1260.527 kN.
          -. Ratio    = Vu / Vr = 0.266  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 372.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 372.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121006,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -372.08      1157.34      1232.31       417.19       377.14
           ---------------------------------------------------------------------------
           DL+LL+Others     -372.08      1157.34      1232.31       417.19       377.14
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -777.389 kN.
          -. Mry        =      2547.128 kN-m.
          -. Mrz        =       790.736 kN-m.
          -. Mr         =      2667.044 kN-m.
          -. Pu/Pr      =   0.479  --->  O.K !
          -. Muy/Mry    =   0.484  --->  O.K !
          -. Muz/Mrz    =   0.477  --->  O.K !
          -. Mu/Mr      =   0.484  --->  O.K !
          -. Ratio      =   0.484  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2197.66 kN.
          -. Vuz    =        149.82 kN.
          -. Muy    =       -767.89 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.47 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75
```

```
          -. Vuy    =       250.99 kN.
          -. Muz    =      -397.64 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61

     ( ). Compute shear strength of concrete.
          -. Vuz       =     149.82 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      863.38 kN.
          -. phiVcz    = phi * Vcz =      777.04 kN.

          -. Vuy       =     250.99 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      819.67 kN.
          -. phiVcy    = phi * Vcy =      737.70 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      603.90 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4100.84 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      603.90 kN.
          -. phiVsz   = phi*Vsz =      543.51 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      593.91 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4144.56 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      593.91 kN.
          -. phiVsy   = phi*Vsy =      534.52 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     292.307 kN.
          -. Vr       =    1272.220 kN.
          -. Ratio    = Vu / Vr = 0.230  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 324.79 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 324.79 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121007,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -363.87      1232.31      1277.95       377.14       346.18
           ---------------------------------------------------------------------------
           DL+LL+Others     -363.87      1232.31      1277.95       377.14       346.18
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -736.110 kN.
          -. Mry        =      2580.639 kN-m.
          -. Mrz        =       713.664 kN-m.
          -. Mr         =      2677.502 kN-m.
          -. Pu/Pr      =   0.494  --->  O.K !
          -. Muy/Mry    =   0.495  --->  O.K !
          -. Muz/Mrz    =   0.485  --->  O.K !
          -. Mu/Mr      =   0.495  --->  O.K !
          -. Ratio      =   0.495  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2209.46 kN.
          -. Vuz    =        114.20 kN.
          -. Muy    =       -798.18 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78
```

```
          -. Vuy    =       226.83 kN.
          -. Muz    =      -295.24 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64

     ( ). Compute shear strength of concrete.
          -. Vuz       =     114.20 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     870.76 kN.
          -. phiVcz    = phi * Vcz =     783.68 kN.

          -. Vuy       =     226.83 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     827.15 kN.
          -. phiVcy    = phi * Vcy =     744.44 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      605.50 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4093.47 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      605.50 kN.
          -. phiVsz   = phi*Vsz =      544.95 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      595.68 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4137.08 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      595.68 kN.
          -. phiVsy   = phi*Vsy =      536.11 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     253.960 kN.
          -. Vr       =    1280.548 kN.
          -. Ratio    = Vu / Vr = 0.198  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 282.18 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 282.18 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121008,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -355.66      1277.95      1296.15       346.18       332.83
           ---------------------------------------------------------------------------
           DL+LL+Others     -355.66      1277.95      1296.15       346.18       332.83
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -710.813 kN.
          -. Mry        =      2595.424 kN-m.
          -. Mrz        =       682.888 kN-m.
          -. Mr         =      2683.759 kN-m.
          -. Pu/Pr      =   0.500  --->  O.K !
          -. Muy/Mry    =   0.499  --->  O.K !
          -. Muz/Mrz    =   0.487  --->  O.K !
          -. Mu/Mr      =   0.500  --->  O.K !
          -. Ratio      =   0.500  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2232.83 kN.
          -. Vuz    =         85.73 kN.
          -. Muy    =       -818.24 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.79
```

```
          -. Vuy    =        203.13 kN.
          -. Muz    =       -220.57 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.79 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.65

     ( ). Compute shear strength of concrete.
          -. Vuz       =       85.73 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      874.65 kN.
          -. phiVcz    = phi * Vcz =      787.18 kN.

          -. Vuy       =      203.13 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      831.10 kN.
          -. phiVcy    = phi * Vcy =      747.99 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      606.34 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4089.58 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      606.34 kN.
          -. phiVsz   = phi*Vsz =      545.71 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      596.60 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4133.13 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      596.60 kN.
          -. phiVsy   = phi*Vsy =      536.94 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     220.482 kN.
          -. Vr       =    1284.932 kN.
          -. Ratio    = Vu / Vr = 0.172  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 244.98 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 244.98 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =2.2669e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =3.0174e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =3.0174e-005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121009,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -355.76      1296.15      1289.42       332.83       332.84
           ------------------------------------------------------------------------------
            DL+LL+Others     -355.76      1296.15      1289.42       332.83       332.84
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -710.813 kN.
          -. Mry        =      2595.424 kN-m.
          -. Mrz        =       682.888 kN-m.
          -. Mr         =      2683.759 kN-m.
          -. Pu/Pr      =   0.501  --->  O.K !
          -. Muy/Mry    =   0.499  --->  O.K !
          -. Muz/Mrz    =   0.487  --->  O.K !
          -. Mu/Mr      =   0.501  --->  O.K !
          -. Ratio      =   0.501  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2244.62 kN.
          -. Vuz    =         73.12 kN.
          -. Muy    =       -808.35 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.34 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80
```

```
          -. Vuy    =       180.18 kN.
          -. Muz    =      -258.30 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.76 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.66

     ( ). Compute shear strength of concrete.
          -. Vuz       =       73.12 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      877.36 kN.
          -. phiVcz    = phi * Vcz =      789.62 kN.

          -. Vuy       =     180.18 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      833.85 kN.
          -. phiVcy    = phi * Vcy =      750.47 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      606.92 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4086.87 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      606.92 kN.
          -. phiVsz   = phi*Vsz =      546.23 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      597.24 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4130.37 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      597.24 kN.
          -. phiVsy   = phi*Vsy =      537.52 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     194.448 kN.
          -. Vr       =    1287.984 kN.
          -. Ratio    = Vu / Vr = 0.151  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 216.05 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 216.05 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-4.5803e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-3.9224e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-3.9224e-005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121010,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -347.54      1289.42      1261.42       332.84       334.46
           ---------------------------------------------------------------------------
           DL+LL+Others     -347.54      1289.42      1261.42       332.84       334.46
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -699.739 kN.
          -. Mry        =      2596.624 kN-m.
          -. Mrz        =       686.819 kN-m.
          -. Mr         =      2685.922 kN-m.
          -. Pu/Pr      =   0.497  --->  O.K !
          -. Muy/Mry    =   0.497  --->  O.K !
          -. Muz/Mrz    =   0.485  --->  O.K !
          -. Mu/Mr      =   0.497  --->  O.K !
          -. Ratio      =   0.497  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2256.40 kN.
          -. Vuz    =         79.46 kN.
          -. Muy    =       -787.26 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.32 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.80
```

```
          -. Vuy    =       158.23 kN.
          -. Muz    =      -305.85 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.74 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67

     ( ). Compute shear strength of concrete.
          -. Vuz       =       79.46 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      879.87 kN.
          -. phiVcz    = phi * Vcz =      791.89 kN.

          -. Vuy       =      158.23 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      836.41 kN.
          -. phiVcy    = phi * Vcy =      752.77 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      607.46 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4084.35 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      607.46 kN.
          -. phiVsz   = phi*Vsz =      546.72 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      597.83 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4127.82 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      597.83 kN.
          -. phiVsy   = phi*Vsy =      538.05 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     177.064 kN.
          -. Vr       =    1290.816 kN.
          -. Ratio    = Vu / Vr = 0.137  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 196.74 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 196.74 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0001 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121011,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -339.31      1261.42      1215.06       334.46       334.33
           ---------------------------------------------------------------------------
           DL+LL+Others     -339.31      1261.42      1215.06       334.46       334.33
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -696.640 kN.
          -. Mry        =      2592.321 kN-m.
          -. Mrz        =       703.268 kN-m.
          -. Mr         =      2686.022 kN-m.
          -. Pu/Pr      =   0.487  --->  O.K !
          -. Muy/Mry    =   0.487  --->  O.K !
          -. Muz/Mrz    =   0.476  --->  O.K !
          -. Mu/Mr      =   0.487  --->  O.K !
          -. Ratio      =   0.487  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2256.60 kN.
          -. Vuz    =         89.38 kN.
          -. Muy    =       -787.26 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.30 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81
```

```
          -. Vuy    =       137.55 kN.
          -. Muz    =      -305.85 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67

     ( ). Compute shear strength of concrete.
          -. Vuz       =      89.38 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      881.78 kN.
          -. phiVcz    = phi * Vcz =      793.61 kN.

          -. Vuy       =     137.55 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      838.35 kN.
          -. phiVcy    = phi * Vcy =      754.52 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      607.87 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4082.44 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      607.87 kN.
          -. phiVsz   = phi*Vsz =      547.08 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      598.28 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4125.88 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      598.28 kN.
          -. phiVsy   = phi*Vsy =      538.45 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     164.041 kN.
          -. Vr       =    1292.967 kN.
          -. Ratio    = Vu / Vr = 0.127  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 182.27 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 182.27 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0001 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121012,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -331.08      1215.06      1140.53       334.33       327.94
           ------------------------------------------------------------------------------
           DL+LL+Others     -331.08      1215.06      1140.53       334.33       327.94
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -703.059 kN.
          -. Mry        =      2583.998 kN-m.
          -. Mrz        =       725.852 kN-m.
          -. Mr         =      2684.010 kN-m.
          -. Pu/Pr      =   0.471  --->  O.K !
          -. Muy/Mry    =   0.470  --->  O.K !
          -. Muz/Mrz    =   0.461  --->  O.K !
          -. Mu/Mr      =   0.471  --->  O.K !
          -. Ratio      =   0.471  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1758.56 kN.
          -. Vuz    =        158.92 kN.
          -. Muy    =      -1195.13 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.67
```

```
          -. Vuy    =         75.99 kN.
          -. Muz    =       -328.57 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.19 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.53

     ( ). Compute shear strength of concrete.
          -. Vuz       =      158.92 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      837.90 kN.
          -. phiVcz    = phi * Vcz =      754.11 kN.

          -. Vuy       =       75.99 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      793.88 kN.
          -. phiVcy    = phi * Vcy =      714.49 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      598.18 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4126.33 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      598.18 kN.
          -. phiVsz   = phi*Vsz =      538.36 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      587.63 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4170.35 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      587.63 kN.
          -. phiVsy   = phi*Vsy =      528.87 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     176.154 kN.
          -. Vr       =    1243.359 kN.
          -. Ratio    = Vu / Vr = 0.142  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 195.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 195.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0022 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0022 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0022 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121013,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -322.84      1140.53      1044.96       327.94       315.21
           ------------------------------------------------------------------------------
            DL+LL+Others     -322.84      1140.53      1044.96       327.94       315.21
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -730.104 kN.
          -. Mry        =      2569.876 kN-m.
          -. Mrz        =       752.198 kN-m.
          -. Mr         =      2677.697 kN-m.
          -. Pu/Pr      =   0.442  --->  O.K !
          -. Muy/Mry    =   0.444  --->  O.K !
          -. Muz/Mrz    =   0.436  --->  O.K !
          -. Mu/Mr      =   0.444  --->  O.K !
          -. Ratio      =   0.444  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1770.22 kN.
          -. Vuz    =        195.89 kN.
          -. Muy    =      -1119.15 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.70
```

```
          -. Vuy    =        66.17 kN.
          -. Muz    =      -321.37 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.56

     ( ). Compute shear strength of concrete.
          -. Vuz       =     195.89 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      847.08 kN.
          -. phiVcz    = phi * Vcz =      762.37 kN.

          -. Vuy       =      66.17 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      803.16 kN.
          -. phiVcy    = phi * Vcy =      722.84 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      600.27 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4117.14 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      600.27 kN.
          -. phiVsz   = phi*Vsz =      540.24 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      589.93 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4161.07 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      589.93 kN.
          -. phiVsy   = phi*Vsy =      530.93 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     206.765 kN.
          -. Vr       =    1253.778 kN.
          -. Ratio    = Vu / Vr = 0.165  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 229.74 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 229.74 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0019 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121014,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -314.60      1044.96       935.34       315.21       297.03
           ---------------------------------------------------------------------------
           DL+LL+Others     -314.60      1044.96       935.34       315.21       297.03
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -767.975 kN.
          -. Mry        =      2552.212 kN-m.
          -. Mrz        =       781.489 kN-m.
          -. Mr         =      2669.178 kN-m.
          -. Pu/Pr      =   0.410  --->  O.K !
          -. Muy/Mry    =   0.409  --->  O.K !
          -. Muz/Mrz    =   0.403  --->  O.K !
          -. Mu/Mr      =   0.410  --->  O.K !
          -. Ratio      =   0.410  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1781.87 kN.
          -. Vuz    =        220.73 kN.
          -. Muy    =      -1023.16 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75
```

```
          -. Vuy    =         58.07 kN.
          -. Muz    =       -308.18 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61

     ( ). Compute shear strength of concrete.
          -. Vuz       =      220.73 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      861.80 kN.
          -. phiVcz    = phi * Vcz =      775.62 kN.

          -. Vuy       =       58.07 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      818.07 kN.
          -. phiVcy    = phi * Vcy =      736.26 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      603.55 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4102.42 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      603.55 kN.
          -. phiVsz   = phi*Vsz =      543.19 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      593.53 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4146.16 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      593.53 kN.
          -. phiVsy   = phi*Vsy =      534.18 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     228.240 kN.
          -. Vr       =    1270.438 kN.
          -. Ratio    = Vu / Vr = 0.180  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 253.60 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 253.60 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0016 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0016 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0016 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121015,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -306.35       935.34       818.07       297.03       274.59
           ------------------------------------------------------------------------------
            DL+LL+Others     -306.35       935.34       818.07       297.03       274.59
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -827.590 kN.
          -. Mry        =      2528.771 kN-m.
          -. Mrz        =       812.952 kN-m.
          -. Mr         =      2656.233 kN-m.
          -. Pu/Pr      =   0.370  --->  O.K !
          -. Muy/Mry    =   0.370  --->  O.K !
          -. Muz/Mrz    =   0.365  --->  O.K !
          -. Mu/Mr      =   0.370  --->  O.K !
          -. Ratio      =   0.370  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1793.52 kN.
          -. Vuz    =        233.84 kN.
          -. Muy    =       -913.96 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.31 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.81
```

```
          -. Vuy    =        54.12 kN.
          -. Muz    =      -289.83 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.72 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.67

     ( ). Compute shear strength of concrete.
          -. Vuz       =     233.84 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     881.33 kN.
          -. phiVcz    = phi * Vcz =     793.19 kN.

          -. Vuy       =      54.12 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     837.89 kN.
          -. phiVcy    = phi * Vcy =     754.10 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      607.77 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4082.90 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      607.77 kN.
          -. phiVsz   = phi*Vsz =      546.99 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      598.17 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4126.34 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      598.17 kN.
          -. phiVsy   = phi*Vsy =      538.35 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     240.022 kN.
          -. Vr       =    1292.451 kN.
          -. Ratio    = Vu / Vr = 0.186  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 266.69 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 266.69 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121016,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -298.10       818.07       698.92       274.59       249.23
           ------------------------------------------------------------------------------
            DL+LL+Others     -298.10       818.07       698.92       274.59       249.23
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =      -908.305 kN.
          -. Mry        =      2499.929 kN-m.
          -. Mrz        =       840.213 kN-m.
          -. Mr         =      2637.347 kN-m.
          -. Pu/Pr      =   0.328  --->  O.K !
          -. Muy/Mry    =   0.327  --->  O.K !
          -. Muz/Mrz    =   0.327  --->  O.K !
          -. Mu/Mr      =   0.328  --->  O.K !
          -. Ratio      =   0.328  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1805.16 kN.
          -. Vuz    =        236.17 kN.
          -. Muy    =       -797.79 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.88
```

```
          -. Vuy    =        55.46 kN.
          -. Muz    =      -267.48 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.75

     ( ). Compute shear strength of concrete.
          -. Vuz       =     236.17 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     904.84 kN.
          -. phiVcz    = phi * Vcz =     814.35 kN.

          -. Vuy       =      55.46 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     861.84 kN.
          -. phiVcy    = phi * Vcy =     775.65 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      612.66 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4059.39 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      612.66 kN.
          -. phiVsz   = phi*Vsz =      551.40 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      603.56 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4102.39 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      603.56 kN.
          -. phiVsy   = phi*Vsy =      543.20 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     242.595 kN.
          -. Vr       =    1318.853 kN.
          -. Ratio    = Vu / Vr = 0.184  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 269.55 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 269.55 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0007 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121017,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -289.85       698.92       582.89       249.23       222.29
           ------------------------------------------------------------------------------
            DL+LL+Others     -289.85       698.92       582.89       249.23       222.29
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1013.323 kN.
          -. Mry        =      2463.201 kN-m.
          -. Mrz        =       878.493 kN-m.
          -. Mr         =      2615.169 kN-m.
          -. Pu/Pr      =   0.286  --->  O.K !
          -. Muy/Mry    =   0.284  --->  O.K !
          -. Muz/Mrz    =   0.284  --->  O.K !
          -. Mu/Mr      =   0.286  --->  O.K !
          -. Ratio      =   0.286  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1816.80 kN.
          -. Vuz    =        229.04 kN.
          -. Muy    =       -680.22 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.88 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.97
```

```
          -. Vuy    =        56.64 kN.
          -. Muz    =      -242.41 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.24 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.83

     ( ). Compute shear strength of concrete.
          -. Vuz       =     229.04 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      931.60 kN.
          -. phiVcz    = phi * Vcz =      838.44 kN.

          -. Vuy       =      56.64 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      889.21 kN.
          -. phiVcy    = phi * Vcy =      800.29 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      618.00 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4032.62 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      618.00 kN.
          -. phiVsz   = phi*Vsz =      556.20 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      609.43 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4075.02 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      609.43 kN.
          -. phiVsy   = phi*Vsy =      548.49 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     235.936 kN.
          -. Vr       =    1348.781 kN.
          -. Ratio    = Vu / Vr = 0.175  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 262.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 262.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0003 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121018,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -791.91       380.65       311.70       350.48       319.08
           ------------------------------------------------------------------------------
            DL+LL+Others     -791.91       380.65       311.70       350.48       319.08
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3215.739 kN.
          -. Mry        =      1566.459 kN-m.
          -. Mrz        =      1431.055 kN-m.
          -. Mr         =      2121.724 kN-m.
          -. Pu/Pr      =   0.246  --->  O.K !
          -. Muy/Mry    =   0.243  --->  O.K !
          -. Muz/Mrz    =   0.245  --->  O.K !
          -. Mu/Mr      =   0.246  --->  O.K !
          -. Ratio      =   0.246  --->  O.K !

 ==========================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ==========================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1828.44 kN.
          -. Vuz    =        214.00 kN.
          -. Muy    =       -566.10 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.65 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.06
```

```
          -. Vuy    =        56.29 kN.
          -. Muz    =      -215.89 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.98 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.93

     ( ). Compute shear strength of concrete.
          -. Vuz       =     214.00 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      960.66 kN.
          -. phiVcz    = phi * Vcz =      864.59 kN.

          -. Vuy       =      56.29 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      919.06 kN.
          -. phiVcy    = phi * Vcy =      827.16 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      623.52 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4003.57 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      623.52 kN.
          -. phiVsz   = phi*Vsz =      561.17 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      615.53 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4045.16 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      615.53 kN.
          -. phiVsy   = phi*Vsy =      553.98 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     221.280 kN.
          -. Vr       =    1381.132 kN.
          -. Ratio    = Vu / Vr = 0.160  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 245.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 245.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121019,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -783.72       311.70       249.23       319.08       284.96
           ------------------------------------------------------------------------------
            DL+LL+Others     -783.72       311.70       249.23       319.08       284.96
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3552.733 kN.
          -. Mry        =      1431.960 kN-m.
          -. Mrz        =      1447.227 kN-m.
          -. Mr         =      2035.921 kN-m.
          -. Pu/Pr      =   0.221  --->  O.K !
          -. Muy/Mry    =   0.218  --->  O.K !
          -. Muz/Mrz    =   0.220  --->  O.K !
          -. Mu/Mr      =   0.221  --->  O.K !
          -. Ratio      =   0.221  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1840.07 kN.
          -. Vuz    =        192.76 kN.
          -. Muy    =       -459.43 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.16
```

```
          -. Vuy    =         54.29 kN.
          -. Muz    =       -189.11 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.73 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.03

     ( ). Compute shear strength of concrete.
          -. Vuz       =      192.76 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      990.91 kN.
          -. phiVcz    = phi * Vcz =      891.81 kN.

          -. Vuy       =       54.29 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      950.28 kN.
          -. phiVcy    = phi * Vcy =      855.25 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      629.00 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3973.32 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      629.00 kN.
          -. phiVsz   = phi*Vsz =      566.10 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      621.58 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4013.95 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      621.58 kN.
          -. phiVsy   = phi*Vsy =      559.42 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     200.254 kN.
          -. Vr       =    1414.673 kN.
          -. Ratio    = Vu / Vr = 0.142  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 222.50 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 222.50 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0007 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0007 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0007 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121020,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -775.52       249.23       194.78       284.96       250.03
           ---------------------------------------------------------------------------
           DL+LL+Others     -775.52       249.23       194.78       284.96       250.03
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3958.059 kN.
          -. Mry        =      1274.320 kN-m.
          -. Mrz        =      1454.116 kN-m.
          -. Mr         =      1933.480 kN-m.
          -. Pu/Pr      =   0.196  --->  O.K !
          -. Muy/Mry    =   0.196  --->  O.K !
          -. Muz/Mrz    =   0.196  --->  O.K !
          -. Mu/Mr      =   0.196  --->  O.K !
          -. Ratio      =   0.196  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1851.70 kN.
          -. Vuz    =        166.96 kN.
          -. Muy    =       -363.35 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.22 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.25
```

```
          -. Vuy    =         50.69 kN.
          -. Muz    =       -163.10 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.49 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.13

     ( ). Compute shear strength of concrete.
          -. Vuz       =      166.96 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1021.16 kN.
          -. phiVcz    = phi * Vcz =      919.05 kN.

          -. Vuy       =       50.69 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      981.66 kN.
          -. phiVcy    = phi * Vcy =      883.50 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      634.21 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3943.06 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      634.21 kN.
          -. phiVsz   = phi*Vsz =      570.79 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      627.35 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     3982.57 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      627.35 kN.
          -. phiVsy   = phi*Vsy =      564.62 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     174.486 kN.
          -. Vr       =    1448.111 kN.
          -. Ratio    = Vu / Vr = 0.120  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 193.87 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 193.87 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0011 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121021,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -767.32       194.78       149.41       250.03       215.96
           ---------------------------------------------------------------------------
           DL+LL+Others     -767.32       194.78       149.41       250.03       215.96
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4365.671 kN.
          -. Mry        =      1124.513 kN-m.
          -. Mrz        =      1429.593 kN-m.
          -. Mr         =      1818.864 kN-m.
          -. Pu/Pr      =   0.176  --->  O.K !
          -. Muy/Mry    =   0.173  --->  O.K !
          -. Muz/Mrz    =   0.175  --->  O.K !
          -. Mu/Mr      =   0.176  --->  O.K !
          -. Ratio      =   0.176  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1863.33 kN.
          -. Vuz    =        138.10 kN.
          -. Muy    =       -280.12 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.02 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.35
```

-. Vuy = 45.74 kN.
-. Muz = -138.70 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 31.28 Deg. [Clause 5.8.3.4.2]
-. betay = 3.23

( ). Compute shear strength of concrete.
-. Vuz = 138.10 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1050.24 kN.
-. phiVcz = phi * Vcz = 945.22 kN.

-. Vuy = 45.74 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1011.96 kN.
-. phiVcy = phi * Vcy = 910.77 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 639.00 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3913.99 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 639.00 kN.
-. phiVsz = phi*Vsz = 575.10 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 632.65 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3952.27 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 632.65 kN.
-. phiVsy = phi*Vsy = 569.39 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 145.479 kN.
-. Vr = 1480.153 kN.
-. Ratio = Vu / Vr = 0.098 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 161.64 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 161.64 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121022,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -759.10       149.41       112.21       215.96       183.79
           ---------------------------------------------------------------------------
           DL+LL+Others     -759.10       149.41       112.21       215.96       183.79
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4866.096 kN.
          -. Mry        =       961.612 kN-m.
          -. Mrz        =      1373.353 kN-m.
          -. Mr         =      1676.543 kN-m.
          -. Pu/Pr      =   0.156  --->  O.K !
          -. Muy/Mry    =   0.155  --->  O.K !
          -. Muz/Mrz    =   0.157  --->  O.K !
          -. Mu/Mr      =   0.157  --->  O.K !
          -. Ratio      =   0.157  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1874.95 kN.
          -. Vuz    =        112.49 kN.
          -. Muy    =       -211.30 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.43
```

```
          -. Vuy    =         40.70 kN.
          -. Muz    =       -116.61 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.10 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.31

     ( ). Compute shear strength of concrete.
          -. Vuz       =      112.49 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1075.87 kN.
          -. phiVcz    = phi * Vcz =      968.29 kN.

          -. Vuy       =       40.70 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     1038.79 kN.
          -. phiVcy    = phi * Vcy =      934.91 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      643.04 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3888.35 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      643.04 kN.
          -. phiVsz   = phi*Vsz =      578.74 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      637.14 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     3925.44 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      637.14 kN.
          -. phiVsy   = phi*Vsy =      573.43 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     119.621 kN.
          -. Vr       =    1508.337 kN.
          -. Ratio    = Vu / Vr = 0.079  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 132.91 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 132.91 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121023,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2397.20      -105.13       -76.07      -180.38      -151.02
           ------------------------------------------------------------------------------
            DL+LL+Others     2397.20      -105.13       -76.07      -180.38      -151.02
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       76.07 kN-m.
           -. End Moments (My2) =      105.13 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =     -105.13 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =     -105.13 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      151.02 kN-m.
          -. End Moments (Mz2) =      180.38 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -180.38 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -180.38 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     16360.130 kN.
          -. Mry        =       723.734 kN-m.
          -. Mrz        =      1241.321 kN-m.
          -. Mr         =      1436.895 kN-m.
          -. Pu/Pr      =   0.147  --->  O.K !
          -. Muy/Mry    =   0.145  --->  O.K !
          -. Muz/Mrz    =   0.145  --->  O.K !
          -. Mu/Mr      =   0.147  --->  O.K !
          -. Ratio      =   0.147  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1886.56 kN.
          -. Vuz    =         91.88 kN.
          -. Muy    =       -155.27 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.74 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.50

          -. Vuy    =         36.20 kN.
          -. Muz    =        -96.92 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.95 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.38
```

( ). Compute shear strength of concrete.
-. Vuz = 91.88 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1097.49 kN.
-. phiVcz = phi * Vcz = 987.74 kN.

-. Vuy = 36.20 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1061.50 kN.
-. phiVcy = phi * Vcy = 955.35 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 646.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3866.73 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 646.33 kN.
-. phiVsz = phi*Vsz = 581.70 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 640.79 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3902.72 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 640.79 kN.
-. phiVsy = phi*Vsy = 576.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 98.758 kN.
-. Vr = 1532.068 kN.
-. Ratio = Vu / Vr = 0.064 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 109.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 109.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0021 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0021 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0021 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121024,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2408.86       -76.07       -53.21      -151.02      -124.34
           ------------------------------------------------------------------------------
            DL+LL+Others     2408.86       -76.07       -53.21      -151.02      -124.34
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       53.21 kN-m.
           -. End Moments (My2) =       76.07 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -76.07 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -76.07 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      124.34 kN-m.
          -. End Moments (Mz2) =      151.02 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -151.02 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -151.02 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =       535.183 kN-m.
          -. Mrz        =      1069.892 kN-m.
          -. Mr         =      1196.282 kN-m.
          -. Pu/Pr      =   0.140  --->  O.K !
          -. Muy/Mry    =   0.142  --->  O.K !
          -. Muz/Mrz    =   0.141  --->  O.K !
          -. Mu/Mr      =   0.142  --->  O.K !
          -. Ratio      =   0.142  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       1898.17 kN.
          -. Vuz    =         72.21 kN.
          -. Muy    =       -109.56 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.63 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.56

          -. Vuy    =         31.54 kN.
          -. Muz    =        -79.42 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.83 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.45
```

( ). Compute shear strength of concrete.
-. Vuz = 72.21 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1116.28 kN.
-. phiVcz = phi * Vcz = 1004.65 kN.

-. Vuy = 31.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1081.30 kN.
-. phiVcy = phi * Vcy = 973.17 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 649.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3847.95 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 649.11 kN.
-. phiVsz = phi*Vsz = 584.20 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 643.88 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3882.92 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 643.88 kN.
-. phiVsy = phi*Vsy = 579.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 78.801 kN.
-. Vr = 1552.665 kN.
-. Ratio = Vu / Vr = 0.051 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 87.56 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 87.56 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0024 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0024 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0024 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121025,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2432.08       -53.21       -36.11      -124.34      -100.62
           ------------------------------------------------------------------------------
            DL+LL+Others     2432.08       -53.21       -36.11      -124.34      -100.62
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       36.11 kN-m.
           -. End Moments (My2) =       53.21 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -36.11 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -36.11 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      100.62 kN-m.
          -. End Moments (Mz2) =      124.34 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -100.62 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -100.62 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =       254.822 kN-m.
          -. Mrz        =       710.169 kN-m.
          -. Mr         =       754.503 kN-m.
          -. Pu/Pr      =   0.142  --->  O.K !
          -. Muy/Mry    =   0.142  --->  O.K !
          -. Muz/Mrz    =   0.142  --->  O.K !
          -. Mu/Mr      =   0.142  --->  O.K !
          -. Ratio      =   0.142  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2420.51 kN.
          -. Vuz    =         35.58 kN.
          -. Muy    =        -53.21 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.95 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.38

          -. Vuy    =         47.75 kN.
          -. Muz    =       -124.34 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.20 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.26
```

( ). Compute shear strength of concrete.
-. Vuz = 35.58 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1061.64 kN.
-. phiVcz = phi * Vcz = 955.48 kN.

-. Vuy = 47.75 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1023.88 kN.
-. phiVcy = phi * Vcy = 921.49 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 640.82 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3902.59 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 640.82 kN.
-. phiVsz = phi*Vsz = 576.73 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 634.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3940.35 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 634.67 kN.
-. phiVsy = phi*Vsy = 571.20 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 59.546 kN.
-. Vr = 1492.695 kN.
-. Ratio = Vu / Vr = 0.040 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 66.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 66.16 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121026,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2443.72       -36.11       -23.33      -100.62       -79.43
           ------------------------------------------------------------------------------
            DL+LL+Others     2443.72       -36.11       -23.33      -100.62       -79.43
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       23.33 kN-m.
           -. End Moments (My2) =       36.11 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -23.33 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -23.33 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       79.43 kN-m.
          -. End Moments (Mz2) =      100.62 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -79.43 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -79.43 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =       163.764 kN-m.
          -. Mrz        =       557.944 kN-m.
          -. Mr         =       581.481 kN-m.
          -. Pu/Pr      =   0.142  --->  O.K !
          -. Muy/Mry    =   0.142  --->  O.K !
          -. Muz/Mrz    =   0.142  --->  O.K !
          -. Mu/Mr      =   0.142  --->  O.K !
          -. Ratio      =   0.142  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2432.15 kN.
          -. Vuz    =         27.12 kN.
          -. Muy    =        -36.11 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.41

          -. Vuy    =         42.65 kN.
          -. Muz    =       -100.62 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.29
```

( ). Compute shear strength of concrete.
-. Vuz = 27.12 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1070.86 kN.
-. phiVcz = phi * Vcz = 963.78 kN.

-. Vuy = 42.65 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1033.54 kN.
-. phiVcy = phi * Vcy = 930.19 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 642.26 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3893.36 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 642.26 kN.
-. phiVsz = phi*Vsz = 578.04 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 636.28 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3930.69 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 636.28 kN.
-. phiVsy = phi*Vsy = 572.65 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 50.544 kN.
-. Vr = 1502.833 kN.
-. Ratio = Vu / Vr = 0.034 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 56.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 56.16 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121027,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2455.35       -23.33       -13.75       -79.43       -60.19
           ------------------------------------------------------------------------------
            DL+LL+Others     2455.35       -23.33       -13.75       -79.43       -60.19
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.75 kN-m.
           -. End Moments (My2) =       23.33 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.75 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.75 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       60.19 kN-m.
          -. End Moments (Mz2) =       79.43 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -60.19 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -60.19 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        96.015 kN-m.
          -. Mrz        =       420.779 kN-m.
          -. Mr         =       431.594 kN-m.
          -. Pu/Pr      =   0.143  --->  O.K !
          -. Muy/Mry    =   0.143  --->  O.K !
          -. Muz/Mrz    =   0.143  --->  O.K !
          -. Mu/Mr      =   0.143  --->  O.K !
          -. Ratio      =   0.143  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2443.79 kN.
          -. Vuz    =         21.43 kN.
          -. Muy    =        -23.33 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.85 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.44

          -. Vuy    =         38.75 kN.
          -. Muz    =        -79.43 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.08 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.32
```

( ). Compute shear strength of concrete.
-. Vuz = 21.43 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1078.34 kN.
-. phiVcz = phi * Vcz = 970.50 kN.

-. Vuy = 38.75 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1041.38 kN.
-. phiVcy = phi * Vcy = 937.24 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 643.42 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3885.89 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 643.42 kN.
-. phiVsz = phi*Vsz = 579.08 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 637.56 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3922.85 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 637.56 kN.
-. phiVsy = phi*Vsy = 573.81 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 44.281 kN.
-. Vr = 1511.043 kN.
-. Ratio = Vu / Vr = 0.029 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 49.20 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 49.20 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0035 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0035 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0035 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121028,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2466.98       -13.75        -8.57       -60.19       -42.81
           ------------------------------------------------------------------------------
            DL+LL+Others     2466.98       -13.75        -8.57       -60.19       -42.81
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.57 kN-m.
           -. End Moments (My2) =       13.75 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       42.81 kN-m.
          -. End Moments (Mz2) =       60.19 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -42.81 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -42.81 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


      ( ). Check tensile reinforcement.
           -. Rho     =     0.0333
           -. Rho > Rho_max  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =     17164.865 kN.
           -. Pr         =     17164.865 kN.
           -. Mry        =        59.145 kN-m.
           -. Mrz        =       297.942 kN-m.
           -. Mr         =       303.756 kN-m.
           -. Pu/Pr      =   0.144  --->  O.K !
           -. Muy/Mry    =   0.145  --->  O.K !
           -. Muz/Mrz    =   0.144  --->  O.K !
           -. Mu/Mr      =   0.145  --->  O.K !
           -. Ratio      =   0.145  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

      ( ). Compute shear parameter. ( LCB = 152, POS = I )
           -. phi    =   0.90
           -. Av     =     0.0003 m^2.
           -. Pu     =       2455.41 kN.
           -. Vuz    =         16.72 kN.
           -. Muy    =        -13.75 kN-m.
           -. bvz    =   1.00 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
           -. thetaz =  30.81 Deg.   [Clause 5.8.3.4.2]
           -. betaz  =   3.46

           -. Vuy    =         35.07 kN.
           -. Muz    =        -60.19 kN-m.
           -. bvy    =   1.00 m.
           -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
           -. thetay =  31.04 Deg.   [Clause 5.8.3.4.2]
           -. betay  =   3.34
```

( ). Compute shear strength of concrete.
-. Vuz = 16.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1084.77 kN.
-. phiVcz = phi * Vcz = 976.30 kN.

-. Vuy = 35.07 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1048.13 kN.
-. phiVcy = phi * Vcy = 943.32 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 644.41 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3879.45 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 644.41 kN.
-. phiVsz = phi*Vsz = 579.97 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 638.66 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3916.10 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 638.66 kN.
-. phiVsy = phi*Vsy = 574.79 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 38.846 kN.
-. Vr = 1518.109 kN.
-. Ratio = Vu / Vr = 0.026 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 43.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 43.16 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121029,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2467.03        -8.57        -9.15       -42.81       -27.18
           ------------------------------------------------------------------------------
            DL+LL+Others     2467.03        -8.57        -9.15       -42.81       -27.18
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.57 kN-m.
           -. End Moments (My2) =        9.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.57 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.57 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       27.18 kN-m.
          -. End Moments (Mz2) =       42.81 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -42.81 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -42.81 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        59.144 kN-m.
          -. Mrz        =       297.936 kN-m.
          -. Mr         =       303.749 kN-m.
          -. Pu/Pr      =   0.144  --->  O.K !
          -. Muy/Mry    =   0.145  --->  O.K !
          -. Muz/Mrz    =   0.144  --->  O.K !
          -. Mu/Mr      =   0.145  --->  O.K !
          -. Ratio      =   0.145  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2467.03 kN.
          -. Vuz    =         13.00 kN.
          -. Muy    =         -8.57 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.78 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.47

          -. Vuy    =         31.70 kN.
          -. Muz    =        -42.81 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.00 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.36
```

( ). Compute shear strength of concrete.
-. Vuz = 13.00 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1090.16 kN.
-. phiVcz = phi * Vcz = 981.14 kN.

-. Vuy = 31.70 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1053.79 kN.
-. phiVcy = phi * Vcy = 948.41 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 645.23 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3874.07 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 645.23 kN.
-. phiVsz = phi*Vsz = 580.71 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 639.57 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3910.44 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 639.57 kN.
-. phiVsy = phi*Vsy = 575.61 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 34.260 kN.
-. Vr = 1524.021 kN.
-. Ratio = Vu / Vr = 0.022 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 38.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 38.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121030,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2490.21        -9.15        -8.97       -27.18       -15.82
           ------------------------------------------------------------------------------
            DL+LL+Others     2490.21        -9.15        -8.97       -27.18       -15.82
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.97 kN-m.
           -. End Moments (My2) =        9.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.97 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.97 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       15.82 kN-m.
          -. End Moments (Mz2) =       27.18 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -15.82 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -15.82 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        62.096 kN-m.
          -. Mrz        =       108.931 kN-m.
          -. Mr         =       125.387 kN-m.
          -. Pu/Pr      =   0.145  --->  O.K !
          -. Muy/Mry    =   0.144  --->  O.K !
          -. Muz/Mrz    =   0.145  --->  O.K !
          -. Mu/Mr      =   0.145  --->  O.K !
          -. Ratio      =   0.145  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2478.64 kN.
          -. Vuz    =          5.47 kN.
          -. Muy    =         -9.15 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.75 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.49

          -. Vuy    =         23.02 kN.
          -. Muz    =        -27.18 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.38
```

( ). Compute shear strength of concrete.
-. Vuz = 5.47 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1095.99 kN.
-. phiVcz = phi * Vcz = 986.39 kN.

-. Vuy = 23.02 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1059.92 kN.
-. phiVcy = phi * Vcy = 953.93 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 646.11 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3868.24 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 646.11 kN.
-. phiVsz = phi*Vsz = 581.50 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 640.54 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3904.31 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 640.54 kN.
-. phiVsy = phi*Vsy = 576.49 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 23.662 kN.
-. Vr = 1530.418 kN.
-. Ratio = Vu / Vr = 0.015 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 26.29 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 26.29 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121031,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2501.81        -8.97        -7.08       -15.82        -8.04
           ------------------------------------------------------------------------------
            DL+LL+Others     2501.81        -8.97        -7.08       -15.82        -8.04
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.08 kN-m.
           -. End Moments (My2) =        8.97 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.08 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.08 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.04 kN-m.
          -. End Moments (Mz2) =       15.82 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.04 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.04 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        48.566 kN-m.
          -. Mrz        =        55.177 kN-m.
          -. Mr         =        73.506 kN-m.
          -. Pu/Pr      =   0.146  --->  O.K !
          -. Muy/Mry    =   0.146  --->  O.K !
          -. Muz/Mrz    =   0.146  --->  O.K !
          -. Mu/Mr      =   0.146  --->  O.K !
          -. Ratio      =   0.146  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2490.24 kN.
          -. Vuz    =          4.41 kN.
          -. Muy    =         -8.97 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.51

          -. Vuy    =         15.71 kN.
          -. Muz    =        -15.82 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.39
```

( ). Compute shear strength of concrete.
-. Vuz = 4.41 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1099.69 kN.
-. phiVcz = phi * Vcz = 989.72 kN.

-. Vuy = 15.71 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1063.82 kN.
-. phiVcy = phi * Vcy = 957.44 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 646.66 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3864.54 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 646.66 kN.
-. phiVsz = phi*Vsz = 582.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 641.16 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3900.41 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 641.16 kN.
-. phiVsy = phi*Vsy = 577.04 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 16.319 kN.
-. Vr = 1534.479 kN.
-. Ratio = Vu / Vr = 0.011 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 18.13 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 18.13 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121032,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2513.40        -7.08        -4.17        -8.04        -3.19
           ------------------------------------------------------------------------------
            DL+LL+Others     2513.40        -7.08        -4.17        -8.04        -3.19
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.17 kN-m.
           -. End Moments (My2) =        7.08 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.17 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.17 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.19 kN-m.
          -. End Moments (Mz2) =        8.04 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.19 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.19 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        28.463 kN-m.
          -. Mrz        =        21.792 kN-m.
          -. Mr         =        35.847 kN-m.
          -. Pu/Pr      =   0.146  --->  O.K !
          -. Muy/Mry    =   0.146  --->  O.K !
          -. Muz/Mrz    =   0.146  --->  O.K !
          -. Mu/Mr      =   0.146  --->  O.K !
          -. Ratio      =   0.146  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2513.40 kN.
          -. Vuz    =          5.92 kN.
          -. Muy    =         -4.17 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.71 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.51

          -. Vuy    =          9.76 kN.
          -. Muz    =         -3.19 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.40
```

( ). Compute shear strength of concrete.
-. Vuz = 5.92 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1101.35 kN.
-. phiVcz = phi * Vcz = 991.21 kN.

-. Vuy = 9.76 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1065.56 kN.
-. phiVcy = phi * Vcy = 959.01 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 646.91 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3862.88 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 646.91 kN.
-. phiVsz = phi*Vsz = 582.22 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 641.43 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3898.66 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 641.43 kN.
-. phiVsy = phi*Vsy = 577.29 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 11.411 kN.
-. Vr = 1536.298 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 12.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 12.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0040 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121033,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2524.98        -4.17        -1.38        -3.19        -0.68
           ------------------------------------------------------------------------------
            DL+LL+Others     2524.98        -4.17        -1.38        -3.19        -0.68
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.38 kN-m.
           -. End Moments (My2) =        4.17 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.38 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.38 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.68 kN-m.
          -. End Moments (Mz2) =        3.19 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.68 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.68 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         9.383 kN-m.
          -. Mrz        =         4.641 kN-m.
          -. Mr         =        10.468 kN-m.
          -. Pu/Pr      =   0.147  --->  O.K !
          -. Muy/Mry    =   0.147  --->  O.K !
          -. Muz/Mrz    =   0.147  --->  O.K !
          -. Mu/Mr      =   0.147  --->  O.K !
          -. Ratio      =   0.147  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2014.06 kN.
          -. Vuz    =          8.70 kN.
          -. Muy    =         -2.16 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.71

          -. Vuy    =          3.21 kN.
          -. Muz    =         -0.57 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.55 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 8.70 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1163.38 kN.
-. phiVcz = phi * Vcz = 1047.04 kN.

-. Vuy = 3.21 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1131.22 kN.
-. phiVcy = phi * Vcy = 1018.10 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 655.75 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3800.84 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 655.75 kN.
-. phiVsz = phi*Vsz = 590.17 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 651.26 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3833.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 651.26 kN.
-. phiVsy = phi*Vsy = 586.14 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 9.273 kN.
-. Vr = 1604.233 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =121034,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2536.56        -1.38         0.00        -0.68         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     2536.56        -1.38         0.00        -0.68         0.00
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        1.38 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.68 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.148  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.148  --->  O.K !
          -. Ratio      =   0.148  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2025.63 kN.
          -. Vuz    =          4.33 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.37 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.71

          -. Vuy    =          1.15 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.54 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.61
```

( ). Compute shear strength of concrete.
-. Vuz = 4.33 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1164.37 kN.
-. phiVcz = phi * Vcz = 1047.93 kN.

-. Vuy = 1.15 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1132.26 kN.
-. phiVcy = phi * Vcy = 1019.04 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 655.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3799.86 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 655.88 kN.
-. phiVsz = phi*Vsz = 590.29 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 651.41 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3831.96 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 651.41 kN.
-. phiVsy = phi*Vsy = 586.27 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 4.477 kN.
-. Vr = 1605.309 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 4.97 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 4.97 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0033 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0033 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0033 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131002,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others          -1044.32       432.36       510.39       955.56       797.24
           ---------------------------------------------------------------------------
           DL+LL+Others    -1044.32       432.36       510.39       955.56       797.24
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2318.416 kN.
          -. Mry        =       955.254 kN-m.
          -. Mrz        =      2133.153 kN-m.
          -. Mr         =      2337.274 kN-m.
          -. Pu/Pr      =   0.450  --->  O.K !
          -. Muy/Mry    =   0.453  --->  O.K !
          -. Muz/Mrz    =   0.448  --->  O.K !
          -. Mu/Mr      =   0.453  --->  O.K !
          -. Ratio      =   0.453  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2174.53 kN.
          -. Vuz    =        507.86 kN.
          -. Muy    =       -710.43 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62
```

```
          -. Vuy    =       184.73 kN.
          -. Muz    =      -568.77 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.36 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48

     ( ). Compute shear strength of concrete.
          -. Vuz       =     507.86 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      822.82 kN.
          -. phiVcz    = phi * Vcz =      740.54 kN.

          -. Vuy       =     184.73 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      778.67 kN.
          -. phiVcy    = phi * Vcy =      700.80 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                  smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                  smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      594.66 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4141.41 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      594.66 kN.
          -. phiVsz   = phi*Vsz =      535.19 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      583.78 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4185.56 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      583.78 kN.
          -. phiVsy   = phi*Vsy =      525.40 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     540.414 kN.
          -. Vr       =    1226.199 kN.
          -. Ratio    = Vu / Vr = 0.441  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 583.78 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 594.66 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0010 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131003,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -921.97       676.21       861.22       554.85       504.50
           ---------------------------------------------------------------------------
           DL+LL+Others     -921.97       676.21       861.22       554.85       504.50
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2183.148 kN.
          -. Mry        =      2041.246 kN-m.
          -. Mrz        =      1195.179 kN-m.
          -. Mr         =      2365.405 kN-m.
          -. Pu/Pr      =   0.422  --->  O.K !
          -. Muy/Mry    =   0.422  --->  O.K !
          -. Muz/Mrz    =   0.422  --->  O.K !
          -. Mu/Mr      =   0.422  --->  O.K !
          -. Ratio      =   0.422  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2186.27 kN.
          -. Vuz    =        424.63 kN.
          -. Muy    =       -885.76 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.59
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```
          -. Vuy    =       170.01 kN.
          -. Muz    =      -515.23 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.48 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.45

     ( ). Compute shear strength of concrete.
          -. Vuz       =     424.63 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      812.36 kN.
          -. phiVcz    = phi * Vcz =      731.12 kN.

          -. Vuy       =     170.01 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      768.14 kN.
          -. phiVcy    = phi * Vcy =      691.32 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. phiVcz/2 < Vuz < phiVcz  --->  Required minimum shear reinforcement.
          -.                 smax_z  = MIN[ smax_z, Av/(0.0316*SQRT(fc')*bvz/fys) ] =    0.245 m.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. phiVcy/2 < Vuy < phiVcy  --->  Required minimum shear reinforcement.
          -.                 smax_y  = MIN[ smax_y, Av/(0.0316*SQRT(fc')*bvy/fys) ] =    0.245 m.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      592.16 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4151.87 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      592.16 kN.
          -. phiVsz   = phi*Vsz =      532.95 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      581.04 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4196.09 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      581.04 kN.
          -. phiVsy   = phi*Vsy =      522.94 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     457.399 kN.
          -. Vr       =    1214.259 kN.
          -. Ratio    = Vu / Vr = 0.377  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 508.22 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 508.22 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0012 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0012 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0012 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131004,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -913.82       861.22      1013.27       504.50       457.36
           ------------------------------------------------------------------------------
            DL+LL+Others     -913.82       861.22      1013.27       504.50       457.36
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1976.451 kN.
          -. Mry        =      2198.069 kN-m.
          -. Mrz        =      1009.625 kN-m.
          -. Mr         =      2418.854 kN-m.
          -. Pu/Pr      =   0.462  --->  O.K !
          -. Muy/Mry    =   0.461  --->  O.K !
          -. Muz/Mrz    =   0.453  --->  O.K !
          -. Mu/Mr      =   0.462  --->  O.K !
          -. Ratio      =   0.462  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2198.00 kN.
          -. Vuz    =        344.24 kN.
          -. Muy    =      -1029.07 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.08 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56
```

-. Vuy = 155.86 kN.
-. Muz = -465.13 kN-m.
-. bvy = 1.00 m.
-. dvy = MAX[dvy_calc, 0.9*dy, 0.72*Bc] = 0.72 m.
-. thetay = 33.59 Deg. [Clause 5.8.3.4.2]
-. betay = 2.42

( ). Compute shear strength of concrete.
-. Vuz = 344.24 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 803.45 kN.
-. phiVcz = phi * Vcz = 723.10 kN.

-. Vuy = 155.86 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 759.18 kN.
-. phiVcy = phi * Vcy = 683.26 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. phiVcz/2 < Vuz < phiVcz ---> Required minimum shear reinforcement.
-. smax_z = MIN[smax_z, Av/(0.0316*SQRT(fc')*bvz/fys)] = 0.245 m.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. phiVcy/2 < Vuy < phiVcy ---> Required minimum shear reinforcement.
-. smax_y = MIN[smax_y, Av/(0.0316*SQRT(fc')*bvy/fys)] = 0.245 m.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 590.00 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 4160.78 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 590.00 kN.
-. phiVsz = phi*Vsz = 531.00 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 578.67 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 4205.05 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 578.67 kN.
-. phiVsy = phi*Vsy = 520.80 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 377.878 kN.
-. Vr = 1204.062 kN.
-. Ratio = Vu / Vr = 0.314 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 419.86 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 419.86 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0014 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131005,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -905.65      1013.27      1131.19       457.36       413.52
           ---------------------------------------------------------------------------
           DL+LL+Others     -905.65      1013.27      1131.19       457.36       413.52
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1851.292 kN.
          -. Mry        =      2293.033 kN-m.
          -. Mrz        =       838.533 kN-m.
          -. Mr         =      2441.544 kN-m.
          -. Pu/Pr      =   0.489  --->  O.K !
          -. Muy/Mry    =   0.493  --->  O.K !
          -. Muz/Mrz    =   0.493  --->  O.K !
          -. Mu/Mr      =   0.493  --->  O.K !
          -. Ratio      =   0.493  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2304.33 kN.
          -. Vuz    =        196.82 kN.
          -. Muy    =       -686.33 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.61 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.71
```

```
          -. Vuy    =       278.60 kN.
          -. Muz    =      -522.87 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.06 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.57

     ( ). Compute shear strength of concrete.
          -. Vuz       =     196.82 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     849.48 kN.
          -. phiVcz    = phi * Vcz =     764.53 kN.

          -. Vuy       =     278.60 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     805.58 kN.
          -. phiVcy    = phi * Vcy =     725.02 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      600.81 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4114.75 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      600.81 kN.
          -. phiVsz   = phi*Vsz =      540.73 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      590.52 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4158.65 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      590.52 kN.
          -. phiVsy   = phi*Vsy =      531.47 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     341.114 kN.
          -. Vr       =    1256.489 kN.
          -. Ratio    = Vu / Vr = 0.271  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 379.02 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 379.02 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0002 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131006,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -897.48      1131.19      1215.88       413.52       374.29
           ---------------------------------------------------------------------------
           DL+LL+Others     -897.48      1131.19      1215.88       413.52       374.29
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1750.279 kN.
          -. Mry        =      2358.073 kN-m.
          -. Mrz        =       717.549 kN-m.
          -. Mr         =      2464.830 kN-m.
          -. Pu/Pr      =   0.513  --->  O.K !
          -. Muy/Mry    =   0.516  --->  O.K !
          -. Muz/Mrz    =   0.522  --->  O.K !
          -. Mu/Mr      =   0.522  --->  O.K !
          -. Ratio      =   0.522  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2316.14 kN.
          -. Vuz    =        152.93 kN.
          -. Muy    =       -741.78 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.52 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.74
```

```
          -. Vuy    =       253.87 kN.
          -. Muz    =      -399.52 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.96 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.60

     ( ). Compute shear strength of concrete.
          -. Vuz       =     152.93 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     858.79 kN.
          -. phiVcz    = phi * Vcz =     772.92 kN.

          -. Vuy       =     253.87 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     815.02 kN.
          -. phiVcy    = phi * Vcy =     733.51 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      602.89 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4105.43 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      602.89 kN.
          -. phiVsz   = phi*Vsz =      542.60 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      592.80 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4149.21 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      592.80 kN.
          -. phiVsy   = phi*Vsy =      533.52 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     296.372 kN.
          -. Vr       =    1267.036 kN.
          -. Ratio    = Vu / Vr = 0.234  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 329.30 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 329.30 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =2.4317e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =3.4759e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =3.4759e-005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131007,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -889.30      1215.88      1270.05       374.29       344.13
           ---------------------------------------------------------------------------
           DL+LL+Others     -889.30      1215.88      1270.05       374.29       344.13
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1686.747 kN.
          -. Mry        =      2394.054 kN-m.
          -. Mrz        =       643.591 kN-m.
          -. Mr         =      2479.053 kN-m.
          -. Pu/Pr      =   0.527  --->  O.K !
          -. Muy/Mry    =   0.531  --->  O.K !
          -. Muz/Mrz    =   0.535  --->  O.K !
          -. Mu/Mr      =   0.535  --->  O.K !
          -. Ratio      =   0.535  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2339.52 kN.
          -. Vuz    =        113.98 kN.
          -. Muy    =       -807.47 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.47 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75
```

```
          -. Vuy    =       229.29 kN.
          -. Muz    =      -227.21 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.91 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61

     ( ). Compute shear strength of concrete.
          -. Vuz       =     113.98 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     863.57 kN.
          -. phiVcz    = phi * Vcz =     777.21 kN.

          -. Vuy       =     229.29 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     819.85 kN.
          -. phiVcy    = phi * Vcy =     737.87 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      603.94 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4100.66 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      603.94 kN.
          -. phiVsz   = phi*Vsz =      543.54 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      593.96 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4144.37 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      593.96 kN.
          -. phiVsy   = phi*Vsy =      534.56 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     256.061 kN.
          -. Vr       =    1272.429 kN.
          -. Ratio    = Vu / Vr = 0.201  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 284.51 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 284.51 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0001 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0001 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0001 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131008,  LCB = 151+,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ===================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -881.12      1270.05      1295.56       344.13       331.89
           ---------------------------------------------------------------------------
           DL+LL+Others     -881.12      1270.05      1295.56       344.13       331.89
           ---------------------------------------------------------------------------

 ===================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1640.555 kN.
          -. Mry        =      2413.826 kN-m.
          -. Mrz        =       612.598 kN-m.
          -. Mr         =      2490.347 kN-m.
          -. Pu/Pr      =   0.537  --->  O.K !
          -. Muy/Mry    =   0.537  --->  O.K !
          -. Muz/Mrz    =   0.542  --->  O.K !
          -. Mu/Mr      =   0.542  --->  O.K !
          -. Ratio      =   0.542  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2351.32 kN.
          -. Vuz    =         81.73 kN.
          -. Muy    =       -817.66 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.45 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.76
```

```
          -. Vuy    =        205.20 kN.
          -. Muz    =       -219.91 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.88 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.62

     ( ). Compute shear strength of concrete.
          -. Vuz       =       81.73 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      866.18 kN.
          -. phiVcz    = phi * Vcz =      779.56 kN.

          -. Vuy       =      205.20 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      822.50 kN.
          -. phiVcy    = phi * Vcy =      740.25 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      604.51 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4098.05 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      604.51 kN.
          -. phiVsz   = phi*Vsz =      544.06 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      594.59 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4141.72 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      594.59 kN.
          -. phiVsy   = phi*Vsy =      535.13 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     220.881 kN.
          -. Vr       =    1275.380 kN.
          -. Ratio    = Vu / Vr = 0.173  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 245.42 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 245.42 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131009,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -881.26      1295.56      1294.81       331.89       333.42
           ---------------------------------------------------------------------------
           DL+LL+Others     -881.26      1295.56      1294.81       331.89       333.42
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1640.555 kN.
          -. Mry        =      2413.826 kN-m.
          -. Mrz        =       612.598 kN-m.
          -. Mr         =      2490.347 kN-m.
          -. Pu/Pr      =   0.537  --->  O.K !
          -. Muy/Mry    =   0.537  --->  O.K !
          -. Muz/Mrz    =   0.542  --->  O.K !
          -. Mu/Mr      =   0.542  --->  O.K !
          -. Ratio      =   0.542  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2363.11 kN.
          -. Vuz    =         62.47 kN.
          -. Muy    =       -813.24 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.43 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.77
```

```
          -. Vuy    =       181.90 kN.
          -. Muz    =      -258.79 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.86 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.63

     ( ). Compute shear strength of concrete.
          -. Vuz       =      62.47 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      868.09 kN.
          -. phiVcz    = phi * Vcz =      781.28 kN.

          -. Vuy       =     181.90 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      824.44 kN.
          -. phiVcy    = phi * Vcy =      742.00 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      604.93 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4096.13 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      604.93 kN.
          -. phiVsz   = phi*Vsz =      544.43 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      595.04 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4139.78 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      595.04 kN.
          -. phiVsy   = phi*Vsy =      535.54 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     192.332 kN.
          -. Vr       =    1277.539 kN.
          -. Ratio    = Vu / Vr = 0.151  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 213.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 213.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0002 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0002 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0002 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131010,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -873.07      1294.81      1272.07       333.42       336.53
           ------------------------------------------------------------------------------
            DL+LL+Others     -873.07      1294.81      1272.07       333.42       336.53
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1639.888 kN.
          -. Mry        =      2413.013 kN-m.
          -. Mrz        =       615.759 kN-m.
          -. Mr         =      2490.339 kN-m.
          -. Pu/Pr      =   0.532  --->  O.K !
          -. Muy/Mry    =   0.537  --->  O.K !
          -. Muz/Mrz    =   0.541  --->  O.K !
          -. Mu/Mr      =   0.541  --->  O.K !
          -. Ratio      =   0.541  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2374.89 kN.
          -. Vuz    =         67.88 kN.
          -. Muy    =       -796.73 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.41 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.77
```

```
          -. Vuy    =       159.66 kN.
          -. Muz    =      -307.65 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.84 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.63

     ( ). Compute shear strength of concrete.
          -. Vuz       =      67.88 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      869.83 kN.
          -. phiVcz    = phi * Vcz =      782.85 kN.

          -. Vuy       =     159.66 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      826.20 kN.
          -. phiVcy    = phi * Vcy =      743.58 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      605.30 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4094.40 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      605.30 kN.
          -. phiVsz   = phi*Vsz =      544.77 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      595.46 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4138.02 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      595.46 kN.
          -. phiVsy   = phi*Vsy =      535.91 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     173.490 kN.
          -. Vr       =    1279.497 kN.
          -. Ratio    = Vu / Vr = 0.136  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 192.77 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 192.77 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131011,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -864.87      1272.07      1229.86       336.53       337.76
           ---------------------------------------------------------------------------
           DL+LL+Others     -864.87      1272.07      1229.86       336.53       337.76
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1636.493 kN.
          -. Mry        =      2408.643 kN-m.
          -. Mrz        =       632.487 kN-m.
          -. Mr         =      2490.301 kN-m.
          -. Pu/Pr      =   0.528  --->  O.K !
          -. Muy/Mry    =   0.528  --->  O.K !
          -. Muz/Mrz    =   0.532  --->  O.K !
          -. Mu/Mr      =   0.532  --->  O.K !
          -. Ratio      =   0.532  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2375.10 kN.
          -. Vuz    =         79.13 kN.
          -. Muy    =       -796.73 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.39 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.78
```

```
          -. Vuy    =       138.73 kN.
          -. Muz    =      -307.65 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.82 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.64

     ( ). Compute shear strength of concrete.
          -. Vuz       =      79.13 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      871.81 kN.
          -. phiVcz    = phi * Vcz =      784.63 kN.

          -. Vuy       =     138.73 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      828.21 kN.
          -. phiVcy    = phi * Vcy =      745.39 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      605.73 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4092.42 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      605.73 kN.
          -. phiVsz   = phi*Vsz =      545.16 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      595.93 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4136.01 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      595.93 kN.
          -. phiVsy   = phi*Vsy =      536.34 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     159.710 kN.
          -. Vr       =    1281.727 kN.
          -. Ratio    = Vu / Vr = 0.125  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 177.46 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 177.46 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0003 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0003 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0003 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131012,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -856.67      1229.86      1157.99       337.76       332.10
           ------------------------------------------------------------------------------
            DL+LL+Others     -856.67      1229.86      1157.99       337.76       332.10
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1658.582 kN.
          -. Mry        =      2396.979 kN-m.
          -. Mrz        =       654.233 kN-m.
          -. Mr         =      2484.659 kN-m.
          -. Pu/Pr      =   0.517  --->  O.K !
          -. Muy/Mry    =   0.513  --->  O.K !
          -. Muz/Mrz    =   0.516  --->  O.K !
          -. Mu/Mr      =   0.517  --->  O.K !
          -. Ratio      =   0.517  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2280.12 kN.
          -. Vuz    =        152.41 kN.
          -. Muy    =      -1210.02 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.09 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.56
```

```
          -. Vuy    =         75.36 kN.
          -. Muz    =       -332.04 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.60 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.42

     ( ). Compute shear strength of concrete.
          -. Vuz       =      152.41 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      802.53 kN.
          -. phiVcz    = phi * Vcz =      722.28 kN.

          -. Vuy       =       75.36 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      758.26 kN.
          -. phiVcy    = phi * Vcy =      682.44 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      589.77 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4161.69 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      589.77 kN.
          -. phiVsz   = phi*Vsz =      530.80 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      578.42 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4205.97 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      578.42 kN.
          -. phiVsy   = phi*Vsy =      520.58 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     170.022 kN.
          -. Vr       =    1203.016 kN.
          -. Ratio    = Vu / Vr = 0.141  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
- phia = 0.75
- phib = 0.90
- phiv = 0.90
- Vs1y = MIN[Vsy, Vuy/phiv] = 188.91 kN.
- Vs1z = MIN[Vsz, Vuz/phiv] = 188.91 kN.
- Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0013 m^2.
- Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0014 m^2.
- As_req = MAX[Asy_req, Asz_req] = 0.0014 m^2.
- As = 0.0261 m^2.
- As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131013,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -848.46      1157.99      1063.82       332.10       320.04
           ------------------------------------------------------------------------------
            DL+LL+Others     -848.46      1157.99      1063.82       332.10       320.04
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1733.816 kN.
          -. Mry        =      2373.116 kN-m.
          -. Mrz        =       676.638 kN-m.
          -. Mr         =      2467.695 kN-m.
          -. Pu/Pr      =   0.489  --->  O.K !
          -. Muy/Mry    =   0.488  --->  O.K !
          -. Muz/Mrz    =   0.491  --->  O.K !
          -. Mu/Mr      =   0.491  --->  O.K !
          -. Ratio      =   0.491  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2291.81 kN.
          -. Vuz    =        192.24 kN.
          -. Muy    =      -1136.72 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  33.01 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.58
```

```
          -. Vuy    =        65.62 kN.
          -. Muz    =      -325.56 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.51 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.44

     ( ). Compute shear strength of concrete.
          -. Vuz       =     192.24 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      810.16 kN.
          -. phiVcz    = phi * Vcz =      729.14 kN.

          -. Vuy       =      65.62 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      765.92 kN.
          -. phiVcy    = phi * Vcy =      689.33 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      591.63 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4154.07 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      591.63 kN.
          -. phiVsz   = phi*Vsz =      532.47 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      580.46 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4198.30 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      580.46 kN.
          -. phiVsy   = phi*Vsy =      522.41 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     203.127 kN.
          -. Vr       =    1211.743 kN.
          -. Ratio    = Vu / Vr = 0.168  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 225.70 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 225.70 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0011 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0011 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0011 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131014,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -840.25      1063.82       954.50       320.04       302.25
           ------------------------------------------------------------------------------
            DL+LL+Others     -840.25      1063.82       954.50       320.04       302.25
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1860.331 kN.
          -. Mry        =      2341.367 kN-m.
          -. Mrz        =       693.397 kN-m.
          -. Mr         =      2441.884 kN-m.
          -. Pu/Pr      =   0.452  --->  O.K !
          -. Muy/Mry    =   0.454  --->  O.K !
          -. Muz/Mrz    =   0.462  --->  O.K !
          -. Mu/Mr      =   0.462  --->  O.K !
          -. Ratio      =   0.462  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2303.49 kN.
          -. Vuz    =        219.40 kN.
          -. Muy    =      -1042.15 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.87 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.62
```

```
          -. Vuy    =        57.67 kN.
          -. Muz    =      -313.04 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.36 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.48

     ( ). Compute shear strength of concrete.
          -. Vuz       =      219.40 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      823.04 kN.
          -. phiVcz    = phi * Vcz =      740.74 kN.

          -. Vuy       =       57.67 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      778.89 kN.
          -. phiVcy    = phi * Vcy =      701.00 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      594.71 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4141.18 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      594.71 kN.
          -. phiVsz   = phi*Vsz =      535.24 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      583.83 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4185.33 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      583.83 kN.
          -. phiVsy   = phi*Vsy =      525.45 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     226.858 kN.
          -. Vr       =    1226.455 kN.
          -. Ratio    = Vu / Vr = 0.185  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 252.06 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 252.06 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0008 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0008 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0008 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131015,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ===============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ===============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -832.03       954.50       836.80       302.25       279.95
           ---------------------------------------------------------------------------
           DL+LL+Others     -832.03       954.50       836.80       302.25       279.95
           ---------------------------------------------------------------------------

 ===============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ===============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -1993.012 kN.
          -. Mry        =      2302.783 kN-m.
          -. Mrz        =       719.441 kN-m.
          -. Mr         =      2412.552 kN-m.
          -. Pu/Pr      =   0.417  --->  O.K !
          -. Muy/Mry    =   0.414  --->  O.K !
          -. Muz/Mrz    =   0.420  --->  O.K !
          -. Mu/Mr      =   0.420  --->  O.K !
          -. Ratio      =   0.420  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2315.16 kN.
          -. Vuz    =        234.34 kN.
          -. Muy    =       -933.26 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.69 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.68
```

```
          -. Vuy    =        53.92 kN.
          -. Muz    =      -295.08 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  33.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.54

     ( ). Compute shear strength of concrete.
          -. Vuz       =      234.34 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      840.51 kN.
          -. phiVcz    = phi * Vcz =      756.46 kN.

          -. Vuy       =       53.92 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      796.52 kN.
          -. phiVcy    = phi * Vcy =      716.86 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      598.77 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4123.72 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      598.77 kN.
          -. phiVsz   = phi*Vsz =      538.90 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      588.29 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4167.71 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      588.29 kN.
          -. phiVsy   = phi*Vsy =      529.46 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     240.462 kN.
          -. Vr       =    1246.323 kN.
          -. Ratio    = Vu / Vr = 0.193  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 267.18 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 267.18 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = 0.0004 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = 0.0004 m^2.
-. As_req = MAX[Asy_req, Asz_req] = 0.0004 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131016,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -823.81       836.80       716.61       279.95       254.52
           ---------------------------------------------------------------------------
           DL+LL+Others     -823.81       836.80       716.61       279.95       254.52
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2212.568 kN.
          -. Mry        =      2244.786 kN-m.
          -. Mrz        =       743.363 kN-m.
          -. Mr         =      2364.667 kN-m.
          -. Pu/Pr      =   0.372  --->  O.K !
          -. Muy/Mry    =   0.373  --->  O.K !
          -. Muz/Mrz    =   0.377  --->  O.K !
          -. Mu/Mr      =   0.377  --->  O.K !
          -. Ratio      =   0.377  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2326.83 kN.
          -. Vuz    =        238.04 kN.
          -. Muy    =       -816.66 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.49 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.75
```

```
          -. Vuy    =        55.60 kN.
          -. Muz    =      -272.85 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.61

     ( ). Compute shear strength of concrete.
          -. Vuz       =      238.04 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      861.74 kN.
          -. phiVcz    = phi * Vcz =      775.57 kN.

          -. Vuy       =       55.60 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      818.00 kN.
          -. phiVcy    = phi * Vcy =      736.20 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      603.54 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4102.49 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      603.54 kN.
          -. phiVsz   = phi*Vsz =      543.18 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      593.52 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4146.23 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      593.52 kN.
          -. phiVsy   = phi*Vsy =      534.16 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     244.445 kN.
          -. Vr       =    1270.365 kN.
          -. Ratio    = Vu / Vr = 0.192  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 271.61 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 271.61 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy =-3.0813e-005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy =-2.2255e-005 m^2.
-. As_req = MAX[Asy_req, Asz_req] =-2.2255e-005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131017,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -815.58       716.61       599.10       254.52       227.34
           ------------------------------------------------------------------------------
            DL+LL+Others     -815.58       716.61       599.10       254.52       227.34
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2467.370 kN.
          -. Mry        =      2177.028 kN-m.
          -. Mrz        =       770.398 kN-m.
          -. Mr         =      2309.321 kN-m.
          -. Pu/Pr      =   0.331  --->  O.K !
          -. Muy/Mry    =   0.329  --->  O.K !
          -. Muz/Mrz    =   0.330  --->  O.K !
          -. Mu/Mr      =   0.331  --->  O.K !
          -. Ratio      =   0.331  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2338.50 kN.
          -. Vuz    =        231.86 kN.
          -. Muy    =       -698.04 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.26 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.82
```

```
          -. Vuy    =        57.10 kN.
          -. Muz    =      -247.70 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.67 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.69

     ( ). Compute shear strength of concrete.
          -. Vuz       =     231.86 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     886.05 kN.
          -. phiVcz    = phi * Vcz =     797.44 kN.

          -. Vuy       =      57.10 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =     842.69 kN.
          -. phiVcy    = phi * Vcy =     758.42 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      608.77 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4078.18 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      608.77 kN.
          -. phiVsz   = phi*Vsz =      547.89 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      599.27 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4121.54 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      599.27 kN.
          -. phiVsy   = phi*Vsy =      539.34 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     238.790 kN.
          -. Vr       =    1297.760 kN.
          -. Ratio    = Vu / Vr = 0.184  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 265.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 265.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0005 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0005 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0005 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131018,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -807.34       599.10       488.57       227.34       199.65
           ------------------------------------------------------------------------------
            DL+LL+Others     -807.34       599.10       488.57       227.34       199.65
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -2787.996 kN.
          -. Mry        =      2090.892 kN-m.
          -. Mrz        =       789.228 kN-m.
          -. Mr         =      2234.885 kN-m.
          -. Pu/Pr      =   0.290  --->  O.K !
          -. Muy/Mry    =   0.287  --->  O.K !
          -. Muz/Mrz    =   0.288  --->  O.K !
          -. Mu/Mr      =   0.290  --->  O.K !
          -. Ratio      =   0.290  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2350.16 kN.
          -. Vuz    =        217.42 kN.
          -. Muy    =       -582.42 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  32.03 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   2.91
```

```
          -. Vuy    =        56.97 kN.
          -. Muz    =      -220.95 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.41 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.77

     ( ). Compute shear strength of concrete.
          -. Vuz       =     217.42 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      912.52 kN.
          -. phiVcz    = phi * Vcz =      821.27 kN.

          -. Vuy       =      56.97 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      869.68 kN.
          -. phiVcy    = phi * Vcy =      782.72 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      614.22 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4051.70 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      614.22 kN.
          -. phiVsz   = phi*Vsz =      552.80 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      605.27 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4094.54 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      605.27 kN.
          -. phiVsy   = phi*Vsy =      544.74 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     224.761 kN.
          -. Vr       =    1327.461 kN.
          -. Ratio    = Vu / Vr = 0.169  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 249.73 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 249.73 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0010 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0010 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0010 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131019,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)            -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -799.10       488.57       388.44       199.65       172.57
           ---------------------------------------------------------------------------
           DL+LL+Others     -799.10       488.57       388.44       199.65       172.57
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3213.897 kN.
          -. Mry        =      1966.950 kN-m.
          -. Mrz        =       796.229 kN-m.
          -. Mr         =      2121.997 kN-m.
          -. Pu/Pr      =   0.249  --->  O.K !
          -. Muy/Mry    =   0.248  --->  O.K !
          -. Muz/Mrz    =   0.251  --->  O.K !
          -. Mu/Mr      =   0.251  --->  O.K !
          -. Ratio      =   0.251  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2361.81 kN.
          -. Vuz    =        196.46 kN.
          -. Muy    =       -473.96 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.81 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.00
```

```
          -. Vuy    =        55.10 kN.
          -. Muz    =      -193.80 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  32.16 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.86

     ( ). Compute shear strength of concrete.
          -. Vuz       =     196.46 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      940.15 kN.
          -. phiVcz    = phi * Vcz =      846.13 kN.

          -. Vuy       =      55.10 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      897.97 kN.
          -. phiVcy    = phi * Vcy =      808.18 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      619.65 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     4024.08 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      619.65 kN.
          -. phiVsz   = phi*Vsz =      557.68 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      611.26 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4066.25 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      611.26 kN.
          -. phiVsy   = phi*Vsy =      550.13 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     204.040 kN.
          -. Vr       =    1358.308 kN.
          -. Ratio    = Vu / Vr = 0.150  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 226.71 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 226.71 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0015 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0015 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0015 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131020,  LCB = 151+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 151+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -790.85       388.44       301.27       172.57       147.05
           ---------------------------------------------------------------------------
           DL+LL+Others     -790.85       388.44       301.27       172.57       147.05
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -3714.306 kN.
          -. Mry        =      1821.705 kN-m.
          -. Mrz        =       801.761 kN-m.
          -. Mr         =      1990.334 kN-m.
          -. Pu/Pr      =   0.213  --->  O.K !
          -. Muy/Mry    =   0.213  --->  O.K !
          -. Muz/Mrz    =   0.215  --->  O.K !
          -. Mu/Mr      =   0.215  --->  O.K !
          -. Ratio      =   0.215  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2373.46 kN.
          -. Vuz    =        170.67 kN.
          -. Muy    =       -375.92 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.59 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.08
```

```
          -. Vuy    =         51.60 kN.
          -. Muz    =       -167.32 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.92 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   2.95

     ( ). Compute shear strength of concrete.
          -. Vuz       =      170.67 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      967.83 kN.
          -. phiVcz    = phi * Vcz =      871.05 kN.

          -. Vuy       =       51.60 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      926.45 kN.
          -. phiVcy    = phi * Vcy =      833.81 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      624.84 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3996.39 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      624.84 kN.
          -. phiVsz   = phi*Vsz =      562.36 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      616.99 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4037.77 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      616.99 kN.
          -. phiVsy   = phi*Vsy =      555.29 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     178.299 kN.
          -. Vr       =    1389.098 kN.
          -. Ratio    = Vu / Vr = 0.128  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 198.11 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 198.11 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0019 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0019 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0019 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131021,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -889.87       201.60       154.70       253.31       218.83
           ---------------------------------------------------------------------------
           DL+LL+Others     -889.87       201.60       154.70       253.31       218.83
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -4735.362 kN.
          -. Mry        =      1069.148 kN-m.
          -. Mrz        =      1337.733 kN-m.
          -. Mr         =      1712.486 kN-m.
          -. Pu/Pr      =   0.188  --->  O.K !
          -. Muy/Mry    =   0.189  --->  O.K !
          -. Muz/Mrz    =   0.189  --->  O.K !
          -. Mu/Mr      =   0.189  --->  O.K !
          -. Ratio      =   0.189  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2385.10 kN.
          -. Vuz    =        141.62 kN.
          -. Muy    =       -290.76 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.40 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.17
```

```
          -. Vuy    =         46.68 kN.
          -. Muz    =       -142.42 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.70 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.04

     ( ). Compute shear strength of concrete.
          -. Vuz       =      141.62 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      994.47 kN.
          -. phiVcz    = phi * Vcz =      895.03 kN.

          -. Vuy       =       46.68 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      953.97 kN.
          -. phiVcy    = phi * Vcy =      858.58 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      629.62 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3969.75 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      629.62 kN.
          -. phiVsz   = phi*Vsz =      566.66 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      622.27 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     4010.25 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      622.27 kN.
          -. phiVsy   = phi*Vsy =      560.05 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     149.116 kN.
          -. Vr       =    1418.623 kN.
          -. Ratio    = Vu / Vr = 0.105  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 165.68 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 165.68 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0023 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0023 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0023 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131022,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ---------------------------------------------------------------------------
           Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
           DL                 -0.00         0.00         0.00         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL              -0.00         0.00         0.00         0.00         0.00
           Others           -881.66       154.70       116.14       218.83       186.25
           ---------------------------------------------------------------------------
           DL+LL+Others     -881.66       154.70       116.14       218.83       186.25
           ---------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5218.167 kN.
          -. Mry        =       906.993 kN-m.
          -. Mrz        =      1283.369 kN-m.
          -. Mr         =      1571.519 kN-m.
          -. Pu/Pr      =   0.169  --->  O.K !
          -. Muy/Mry    =   0.171  --->  O.K !
          -. Muz/Mrz    =   0.171  --->  O.K !
          -. Mu/Mr      =   0.171  --->  O.K !
          -. Ratio      =   0.171  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2396.74 kN.
          -. Vuz    =        115.70 kN.
          -. Muy    =       -220.11 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.24 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.24
```

```
          -. Vuy    =         41.62 kN.
          -. Muz    =       -119.81 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.52 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.12

     ( ). Compute shear strength of concrete.
          -. Vuz       =      115.70 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1018.01 kN.
          -. phiVcz    = phi * Vcz =      916.21 kN.

          -. Vuy       =       41.62 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      978.39 kN.
          -. phiVcy    = phi * Vcy =      880.55 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      633.68 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3946.21 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      633.68 kN.
          -. phiVsz   = phi*Vsz =      570.31 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      626.76 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     3985.84 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      626.76 kN.
          -. phiVsy   = phi*Vsy =      564.09 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     122.959 kN.
          -. Vr       =    1444.634 kN.
          -. Ratio    = Vu / Vr = 0.085  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 136.62 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 136.62 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0027 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0027 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0027 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

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--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131023,  LCB = 152+,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152+
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           -873.43       116.14        84.39       186.25       155.94
           ------------------------------------------------------------------------------
            DL+LL+Others     -873.43       116.14        84.39       186.25       155.94
           ------------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090

     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     -5678.471 kN.
          -. Mry        =       753.657 kN-m.
          -. Mrz        =      1222.538 kN-m.
          -. Mr         =      1436.175 kN-m.
          -. Pu/Pr      =   0.154  --->  O.K !
          -. Muy/Mry    =   0.154  --->  O.K !
          -. Muz/Mrz    =   0.152  --->  O.K !
          -. Mu/Mr      =   0.154  --->  O.K !
          -. Ratio      =   0.154  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2408.37 kN.
          -. Vuz    =         94.77 kN.
          -. Muy    =       -162.41 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  31.10 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.31
```

```
          -. Vuy    =         37.09 kN.
          -. Muz    =        -99.61 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.37 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.18

     ( ). Compute shear strength of concrete.
          -. Vuz       =       94.77 kN.
          -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =     1037.92 kN.
          -. phiVcz    = phi * Vcz =      934.13 kN.

          -. Vuy       =       37.09 kN.
          -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      999.11 kN.
          -. phiVcy    = phi * Vcy =      899.20 kN.

     ( ). Compute maximum spacing of ties.
          -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.576 m.
          -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
          -. Applied spacing s_z   =    0.200 m.

          -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.576 m.
          -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
          -. Applied spacing s_y   =    0.200 m.

          -. Applied spacing s     = MIN[ s_y, s_z ] =    0.200 m.

     ( ). Compute shear strength of reinforcement.
          -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      637.00 kN.
          -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     3926.31 kN.
          -. Vsz      = MIN[ Vsz, Vsz_lim ] =      637.00 kN.
          -. phiVsz   = phi*Vsz =      573.30 kN.
          -. phiVsz > (Vuz-phiVcz)  --->  O.K !
          -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0013 m^2/m.

          -. Vsy      = Av*fys*dvy*cot(thetay) / s =      630.43 kN.
          -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =     3965.12 kN.
          -. Vsy      = MIN[ Vsy, Vsy_lim ] =      630.43 kN.
          -. phiVsy   = phi*Vsy =      567.39 kN.
          -. phiVsy > (Vuy-phiVcy)  --->  O.K !
          -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0013 m^2/m.

          -. Vu       =     101.766 kN.
          -. Vr       =    1466.587 kN.
          -. Ratio    = Vu / Vr = 0.069  --->  O.K !
```

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 113.07 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 113.07 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0029 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0029 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0029 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131024,  LCB = 152-,  POS =    I

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2527.38       -78.83       -54.91      -153.08      -126.03
           ------------------------------------------------------------------------------
            DL+LL+Others     2527.38       -78.83       -54.91      -153.08      -126.03
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       54.91 kN-m.
           -. End Moments (My2) =       78.83 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -78.83 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -78.83 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      126.03 kN-m.
          -. End Moments (Mz2) =      153.08 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -153.08 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -153.08 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =       530.924 kN-m.
          -. Mrz        =      1037.280 kN-m.
          -. Mr         =      1165.260 kN-m.
          -. Pu/Pr      =   0.147  --->  O.K !
          -. Muy/Mry    =   0.148  --->  O.K !
          -. Muz/Mrz    =   0.148  --->  O.K !
          -. Mu/Mr      =   0.148  --->  O.K !
          -. Ratio      =   0.148  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2420.00 kN.
          -. Vuz    =         74.72 kN.
          -. Muy    =       -115.18 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.99 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.36

          -. Vuy    =         32.35 kN.
          -. Muz    =        -81.62 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.24 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.24
```

( ). Compute shear strength of concrete.
-. Vuz = 74.72 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1055.27 kN.
-. phiVcz = phi * Vcz = 949.74 kN.

-. Vuy = 32.35 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1017.22 kN.
-. phiVcy = phi * Vcy = 915.49 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 639.80 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3908.96 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 639.80 kN.
-. phiVsz = phi*Vsz = 575.82 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 633.55 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3947.01 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 633.55 kN.
-. phiVsy = phi*Vsy = 570.19 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 81.421 kN.
-. Vr = 1485.686 kN.
-. Ratio = Vu / Vr = 0.055 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 90.47 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 90.47 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0032 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0032 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0032 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131025,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2550.60       -54.91       -36.93      -126.03      -101.98
           ------------------------------------------------------------------------------
            DL+LL+Others     2550.60       -54.91       -36.93      -126.03      -101.98
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       36.93 kN-m.
           -. End Moments (My2) =       54.91 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -36.93 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -36.93 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =      101.98 kN-m.
          -. End Moments (Mz2) =      126.03 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =     -101.98 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =     -101.98 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =       248.547 kN-m.
          -. Mrz        =       686.319 kN-m.
          -. Mr         =       729.937 kN-m.
          -. Pu/Pr      =   0.149  --->  O.K !
          -. Muy/Mry    =   0.149  --->  O.K !
          -. Muz/Mrz    =   0.149  --->  O.K !
          -. Mu/Mr      =   0.149  --->  O.K !
          -. Ratio      =   0.149  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2431.62 kN.
          -. Vuz    =         56.06 kN.
          -. Muy    =        -77.99 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.90 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.41

          -. Vuy    =         27.63 kN.
          -. Muz    =        -65.93 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.14 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.29
```

( ). Compute shear strength of concrete.
-. Vuz = 56.06 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1069.76 kN.
-. phiVcz = phi * Vcz = 962.79 kN.

-. Vuy = 27.63 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1032.38 kN.
-. phiVcy = phi * Vcy = 929.15 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 642.09 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3894.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 642.09 kN.
-. phiVsz = phi*Vsz = 577.88 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 636.08 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3931.84 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 636.08 kN.
-. phiVsy = phi*Vsy = 572.48 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 62.494 kN.
-. Vr = 1501.623 kN.
-. Ratio = Vu / Vr = 0.042 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 69.44 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 69.44 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0034 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0034 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0034 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2020
================================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131026,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2562.25       -36.93       -23.43      -101.98       -80.49
           ---------------------------------------------------------------------------
            DL+LL+Others     2562.25       -36.93       -23.43      -101.98       -80.49
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       23.43 kN-m.
           -. End Moments (My2) =       36.93 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -23.43 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -23.43 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       80.49 kN-m.
          -. End Moments (Mz2) =      101.98 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -80.49 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -80.49 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =       156.834 kN-m.
          -. Mrz        =       539.248 kN-m.
          -. Mr         =       561.592 kN-m.
          -. Pu/Pr      =   0.149  --->  O.K !
          -. Muy/Mry    =   0.149  --->  O.K !
          -. Muz/Mrz    =   0.149  --->  O.K !
          -. Mu/Mr      =   0.149  --->  O.K !
          -. Ratio      =   0.149  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2550.68 kN.
          -. Vuz    =         28.16 kN.
          -. Muy    =        -36.93 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.98 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.37

          -. Vuy    =         43.23 kN.
          -. Muz    =       -101.98 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.23 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.25
```

( ). Compute shear strength of concrete.
-. Vuz = 28.16 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1057.38 kN.
-. phiVcz = phi * Vcz = 951.64 kN.

-. Vuy = 43.23 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1019.42 kN.
-. phiVcy = phi * Vcy = 917.48 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 640.14 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3906.85 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 640.14 kN.
-. phiVsz = phi*Vsz = 576.13 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 633.92 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3944.81 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 633.92 kN.
-. phiVsy = phi*Vsy = 570.53 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 51.591 kN.
-. Vr = 1488.005 kN.
-. Ratio = Vu / Vr = 0.035 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 57.32 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 57.32 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0036 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0036 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0036 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131027,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2573.88       -23.43       -13.20       -80.49       -60.98
           ------------------------------------------------------------------------------
            DL+LL+Others     2573.88       -23.43       -13.20       -80.49       -60.98
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =       13.20 kN-m.
           -. End Moments (My2) =       23.43 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =      -13.20 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =      -13.20 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       60.98 kN-m.
          -. End Moments (Mz2) =       80.49 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -60.98 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -60.98 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        87.726 kN-m.
          -. Mrz        =       406.705 kN-m.
          -. Mr         =       416.059 kN-m.
          -. Pu/Pr      =   0.150  --->  O.K !
          -. Muy/Mry    =   0.150  --->  O.K !
          -. Muz/Mrz    =   0.150  --->  O.K !
          -. Mu/Mr      =   0.150  --->  O.K !
          -. Ratio      =   0.150  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2562.31 kN.
          -. Vuz    =         22.23 kN.
          -. Muy    =        -23.43 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.93 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.39

          -. Vuy    =         39.28 kN.
          -. Muz    =        -80.49 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.17 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.27
```

( ). Compute shear strength of concrete.
-. Vuz = 22.23 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1064.86 kN.
-. phiVcz = phi * Vcz = 958.37 kN.

-. Vuy = 39.28 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1027.25 kN.
-. phiVcy = phi * Vcy = 924.52 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 641.32 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3899.37 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 641.32 kN.
-. phiVsz = phi*Vsz = 577.19 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 635.23 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3936.98 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 635.23 kN.
-. phiVsy = phi*Vsy = 571.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 45.132 kN.
-. Vr = 1496.233 kN.
-. Ratio = Vu / Vr = 0.030 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 50.15 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 50.15 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0037 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0037 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0037 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131028,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2585.51       -13.20        -7.06       -60.98       -43.35
           ------------------------------------------------------------------------------
            DL+LL+Others     2585.51       -13.20        -7.06       -60.98       -43.35
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.06 kN-m.
           -. End Moments (My2) =       13.20 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -7.06 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -7.06 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       43.35 kN-m.
          -. End Moments (Mz2) =       60.98 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -43.35 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -43.35 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        47.481 kN-m.
          -. Mrz        =       287.687 kN-m.
          -. Mr         =       291.579 kN-m.
          -. Pu/Pr      =   0.151  --->  O.K !
          -. Muy/Mry    =   0.149  --->  O.K !
          -. Muz/Mrz    =   0.151  --->  O.K !
          -. Mu/Mr      =   0.151  --->  O.K !
          -. Ratio      =   0.151  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2573.94 kN.
          -. Vuz    =         17.30 kN.
          -. Muy    =        -13.20 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.89 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.41

          -. Vuy    =         35.54 kN.
          -. Muz    =        -60.98 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.13 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.30
```

( ). Compute shear strength of concrete.
-. Vuz = 17.30 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1071.29 kN.
-. phiVcz = phi * Vcz = 964.16 kN.

-. Vuy = 35.54 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1033.99 kN.
-. phiVcy = phi * Vcy = 930.59 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 642.33 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3892.94 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 642.33 kN.
-. phiVsz = phi*Vsz = 578.10 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 636.35 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3930.24 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 636.35 kN.
-. phiVsy = phi*Vsy = 572.71 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 39.529 kN.
-. Vr = 1503.302 kN.
-. Ratio = Vu / Vr = 0.026 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 43.92 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 43.92 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0038 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0038 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0038 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131029,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2597.13        -7.06        -8.12       -43.35       -27.50
           ------------------------------------------------------------------------------
            DL+LL+Others     2597.13        -7.06        -8.12       -43.35       -27.50
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        7.06 kN-m.
           -. End Moments (My2) =        8.12 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.12 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.12 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       27.50 kN-m.
          -. End Moments (Mz2) =       43.35 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -27.50 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -27.50 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        53.643 kN-m.
          -. Mrz        =       181.754 kN-m.
          -. Mr         =       189.505 kN-m.
          -. Pu/Pr      =   0.151  --->  O.K !
          -. Muy/Mry    =   0.151  --->  O.K !
          -. Muz/Mrz    =   0.151  --->  O.K !
          -. Mu/Mr      =   0.151  --->  O.K !
          -. Ratio      =   0.151  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2585.56 kN.
          -. Vuz    =         13.38 kN.
          -. Muy    =         -7.06 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.86 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.43

          -. Vuy    =         32.13 kN.
          -. Muz    =        -43.35 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.09 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.31
```

( ). Compute shear strength of concrete.
-. Vuz = 13.38 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1076.69 kN.
-. phiVcz = phi * Vcz = 969.02 kN.

-. Vuy = 32.13 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1039.65 kN.
-. phiVcy = phi * Vcy = 935.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 643.17 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3887.53 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 643.17 kN.
-. phiVsz = phi*Vsz = 578.85 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 637.28 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3924.58 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 637.28 kN.
-. phiVsy = phi*Vsy = 573.55 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 34.805 kN.
-. Vr = 1509.236 kN.
-. Ratio = Vu / Vr = 0.023 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 38.67 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 38.67 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0039 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0039 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0039 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131030,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2608.74        -8.12        -8.52       -27.50       -15.99
           ------------------------------------------------------------------------------
            DL+LL+Others     2608.74        -8.12        -8.52       -27.50       -15.99
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        8.12 kN-m.
           -. End Moments (My2) =        8.52 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -8.52 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -8.52 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =       15.99 kN-m.
          -. End Moments (Mz2) =       27.50 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =      -15.99 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =      -15.99 kN-m.

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        56.159 kN-m.
          -. Mrz        =       105.163 kN-m.
          -. Mr         =       119.219 kN-m.
          -. Pu/Pr      =   0.152  --->  O.K !
          -. Muy/Mry    =   0.152  --->  O.K !
          -. Muz/Mrz    =   0.152  --->  O.K !
          -. Mu/Mr      =   0.152  --->  O.K !
          -. Ratio      =   0.152  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2597.17 kN.
          -. Vuz    =          5.30 kN.
          -. Muy    =         -8.12 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.83 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.45

          -. Vuy    =         23.32 kN.
          -. Muz    =        -27.50 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.05 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.33
```

( ). Compute shear strength of concrete.
-. Vuz = 5.30 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1082.53 kN.
-. phiVcz = phi * Vcz = 974.27 kN.

-. Vuy = 23.32 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1045.77 kN.
-. phiVcy = phi * Vcy = 941.20 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 644.07 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3881.70 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 644.07 kN.
-. phiVsz = phi*Vsz = 579.66 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 638.28 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3918.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 638.28 kN.
-. phiVsy = phi*Vsy = 574.45 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 23.919 kN.
-. Vr = 1515.644 kN.
-. Ratio = Vu / Vr = 0.016 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 26.58 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 26.58 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0040 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0040 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0040 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131031,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2620.34        -8.52        -6.93       -15.99        -8.12
           ------------------------------------------------------------------------------
            DL+LL+Others     2620.34        -8.52        -6.93       -15.99        -8.12
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        6.93 kN-m.
           -. End Moments (My2) =        8.52 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -6.93 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -6.93 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        8.12 kN-m.
          -. End Moments (Mz2) =       15.99 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -8.12 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -8.12 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
---------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
=======================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        45.390 kN-m.
          -. Mrz        =        53.186 kN-m.
          -. Mr         =        69.921 kN-m.
          -. Pu/Pr      =   0.153  --->  O.K !
          -. Muy/Mry    =   0.153  --->  O.K !
          -. Muz/Mrz    =   0.153  --->  O.K !
          -. Mu/Mr      =   0.153  --->  O.K !
          -. Ratio      =   0.153  --->  O.K !

 ======================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ======================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = I )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2608.77 kN.
          -. Vuz    =          3.79 kN.
          -. Muy    =         -8.52 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.80 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.46

          -. Vuy    =         15.90 kN.
          -. Muz    =        -15.99 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.03 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.35
```

( ). Compute shear strength of concrete.
-. Vuz = 3.79 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1086.21 kN.
-. phiVcz = phi * Vcz = 977.59 kN.

-. Vuy = 15.90 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1049.64 kN.
-. phiVcy = phi * Vcy = 944.68 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 644.63 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3878.02 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 644.63 kN.
-. phiVsz = phi*Vsz = 580.17 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 638.90 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3914.59 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 638.90 kN.
-. phiVsy = phi*Vsy = 575.01 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 16.345 kN.
-. Vr = 1519.688 kN.
-. Ratio = Vu / Vr = 0.011 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 18.16 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 18.16 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2020
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131032,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2631.93        -6.93        -4.15        -8.12        -3.22
           ------------------------------------------------------------------------------
            DL+LL+Others     2631.93        -6.93        -4.15        -8.12        -3.22
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        4.15 kN-m.
           -. End Moments (My2) =        6.93 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -4.15 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -4.15 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        3.22 kN-m.
          -. End Moments (Mz2) =        8.12 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -3.22 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -3.22 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                            Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =        27.028 kN-m.
          -. Mrz        =        21.000 kN-m.
          -. Mr         =        34.227 kN-m.
          -. Pu/Pr      =   0.153  --->  O.K !
          -. Muy/Mry    =   0.153  --->  O.K !
          -. Muz/Mrz    =   0.153  --->  O.K !
          -. Mu/Mr      =   0.153  --->  O.K !
          -. Ratio      =   0.153  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 152, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2631.93 kN.
          -. Vuz    =          5.65 kN.
          -. Muy    =         -4.15 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.79 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.47

          -. Vuy    =          9.86 kN.
          -. Muz    =         -3.22 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  31.02 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.35
```

( ). Compute shear strength of concrete.
-. Vuz = 5.65 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1087.83 kN.
-. phiVcz = phi * Vcz = 979.05 kN.

-. Vuy = 9.86 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1051.35 kN.
-. phiVcy = phi * Vcy = 946.21 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 644.88 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3876.39 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 644.88 kN.
-. phiVsz = phi*Vsz = 580.39 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 639.18 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3912.88 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 639.18 kN.
-. phiVsy = phi*Vsy = 575.26 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 11.364 kN.
-. Vr = 1521.469 kN.
-. Ratio = Vu / Vr = 0.007 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 12.63 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 12.63 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0042 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0042 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0042 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131033,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2643.51        -4.15        -1.39        -3.22        -0.69
           ------------------------------------------------------------------------------
            DL+LL+Others     2643.51        -4.15        -1.39        -3.22        -0.69
           ------------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        1.39 kN-m.
           -. End Moments (My2) =        4.15 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =       -1.39 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =       -1.39 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.69 kN-m.
          -. End Moments (Mz2) =        3.22 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =       -0.69 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =       -0.69 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         9.004 kN-m.
          -. Mrz        =         4.467 kN-m.
          -. Mr         =        10.052 kN-m.
          -. Pu/Pr      =   0.154  --->  O.K !
          -. Muy/Mry    =   0.154  --->  O.K !
          -. Muz/Mrz    =   0.154  --->  O.K !
          -. Mu/Mr      =   0.154  --->  O.K !
          -. Ratio      =   0.154  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2535.95 kN.
          -. Vuz    =          8.64 kN.
          -. Muy    =         -2.17 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.51

          -. Vuy    =          3.19 kN.
          -. Muz    =         -0.57 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.94 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.39
```

( ). Compute shear strength of concrete.
-. Vuz = 8.64 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1099.76 kN.
-. phiVcz = phi * Vcz = 989.79 kN.

-. Vuy = 3.19 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1063.89 kN.
-. phiVcy = phi * Vcy = 957.50 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 646.67 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3864.46 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 646.67 kN.
-. phiVsz = phi*Vsz = 582.01 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

-. Vsy = Av*fys*dvy*cot(thetay) / s = 641.17 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3900.33 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 641.17 kN.
-. phiVsy = phi*Vsy = 577.05 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 9.208 kN.
-. Vr = 1534.558 kN.
-. Ratio = Vu / Vr = 0.006 ---> O.K !

( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 10.23 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 10.23 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
==========================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =131034,  LCB = 152-,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =    63) : Pilote_1.00
        Column Height (L)               =         0.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         1.000 m.
        Concrete Strength (fc)          =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Ties/Spirals Strength (fys)     =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------------------------------
          Layer         Pos1    As( m^2.)         Pos2    As( m^2.)         Pos3    As( m^2.)
        ---------------------------------------------------------------------------------
            1         18-#14 (    0.0261)           -                         -
        ---------------------------------------------------------------------------------

      *.Ties :  2.0-#4  @200

 ==========================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ==========================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID = 152-
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL                 -0.00         0.00         0.00         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL              -0.00         0.00         0.00         0.00         0.00
            Others           2655.09        -1.39         0.00        -0.69         0.00
           ---------------------------------------------------------------------------
            DL+LL+Others     2655.09        -1.39         0.00        -0.69         0.00
           ---------------------------------------------------------------------------

      ( ). Check slenderness ratios of BRACED/UNBRACED frame.
           -. End Moments (My1) =        0.00 kN-m.
           -. End Moments (My2) =        1.39 kN-m.
           -. Slenderness ratio limits.
              SRy(Unbraced) =  22.00
```

```
          -. Radii of gyration (Roy)        =    0.250 m.
          -. Unbraced lengths  (Ly)         =    0.500 m.
          -. Effective length factors (Ky)  =    1.000
          -. SLENy  =  Ky*Ly/Roy  =    2.000  <  SRy  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for major axis(DBy,DSy).
          -. DBy    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_y  =  My_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_y  =  My_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcy             =  DBy*QMb_y + DSy*QMs_y            =        0.00 kN-m.

     ( ). Check slenderness ratios of BRACED/UNBRACED frame.
          -. End Moments (Mz1) =        0.00 kN-m.
          -. End Moments (Mz2) =        0.69 kN-m.
          -. Slenderness ratio limits.
             SRz(Unbraced) =  22.00
          -. Radii of gyration (Roz)        =    0.250 m.
          -. Unbraced lengths  (Lz)         =    0.500 m.
          -. Effective length factors (Kz)  =    1.000
          -. SLENz  =  Kz*Lz/Roz  =    2.000  <  SRz  --->  NOT SLENDER.

     ( ). Compute moment magnification factors for minor axis(DBz,DSz).
          -. DBz    =     1.00 (Default value)

     ( ). Compute magnified moments.
          -. No sidesway moments.
             QMb_z  =  Mz_G   =        0.00 kN-m.
          -. Sidesway moments.
             QMs_z  =  Mz_S   =        0.00 kN-m.
          -. Compute magnified moments.
             Mcz             =  DBz*QMb_z + DSz*QMs_z            =        0.00 kN-m.

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================

     ( ). Compute design parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Rhomax1 =   0.0300 (User Input)
          -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0300
          -. Rhomin  = 0.135*fc'/fy =   0.0090
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                          Civil 2020
============================================================================================


     ( ). Check tensile reinforcement.
          -. Rho     =     0.0333
          -. Rho > Rho_max  --->  Not Acceptable !!!

     ( ). Check moment capacity.
          -. Pr_max     =     17164.865 kN.
          -. Pr         =     17164.865 kN.
          -. Mry        =         0.000 kN-m.
          -. Mrz        =         0.000 kN-m.
          -. Mr         =         0.000 kN-m.
          -. Pu/Pr      =   0.155  --->  O.K !
          -. Muy/Mry    =   0.000  --->  O.K !
          -. Muz/Mrz    =   0.000  --->  O.K !
          -. Mu/Mr      =   0.155  --->  O.K !
          -. Ratio      =   0.155  --->  O.K !

 ============================================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================================

     ( ). Compute shear parameter. ( LCB = 151, POS = J )
          -. phi    =   0.90
          -. Av     =     0.0003 m^2.
          -. Pu     =       2547.53 kN.
          -. Vuz    =          4.34 kN.
          -. Muy    =          0.00 kN-m.
          -. bvz    =   1.00 m.
          -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.72 m.
          -. thetaz =  30.72 Deg.   [Clause 5.8.3.4.2]
          -. betaz  =   3.51

          -. Vuy    =          1.14 kN.
          -. Muz    =          0.00 kN-m.
          -. bvy    =   1.00 m.
          -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.72 m.
          -. thetay =  30.93 Deg.   [Clause 5.8.3.4.2]
          -. betay  =   3.39
```

( ). Compute shear strength of concrete.
-. Vuz = 4.34 kN.
-. Vcz = 0.0316*betaz*SQRT[fc']*bvz*dvz = 1100.61 kN.
-. phiVcz = phi * Vcz = 990.55 kN.

-. Vuy = 1.14 kN.
-. Vcy = 0.0316*betay*SQRT[fc']*bvy*dvy = 1064.78 kN.
-. phiVcy = phi * Vcy = 958.30 kN.

( ). Compute maximum spacing of ties.
-. Maximum spacing smax_z = MIN[0.8*dvz, 24 in] = 0.576 m.
-. Vuz < phiVcz/2 ---> Not required shear reinforcement.
-. Applied spacing s_z = 0.200 m.

-. Maximum spacing smax_y = MIN[0.8*dvy, 24 in] = 0.576 m.
-. Vuy < phiVcy/2 ---> Not required shear reinforcement.
-. Applied spacing s_y = 0.200 m.

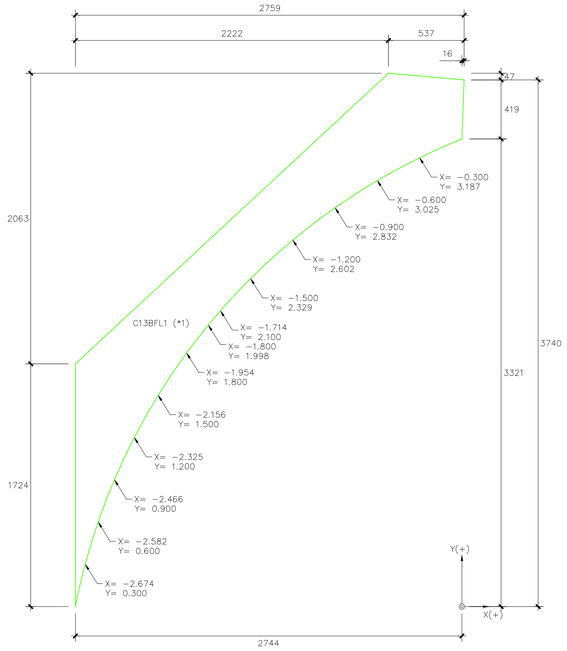
-. Applied spacing s = MIN[s_y, s_z] = 0.200 m.

( ). Compute shear strength of reinforcement.
-. Vsz = Av*fys*dvz*cot(thetaz) / s = 646.80 kN.
-. Vsz_lim = 0.25*fc'*bvz*dvz - Vcz = 3863.62 kN.
-. Vsz = MIN[Vsz, Vsz_lim] = 646.80 kN.
-. phiVsz = phi*Vsz = 582.12 kN.
-. phiVsz > (Vuz-phiVcz) ---> O.K !
-. Using Avz/s = Vsz / (fys*dvz*cot(thetaz)) = 0.0013 m^2/m.

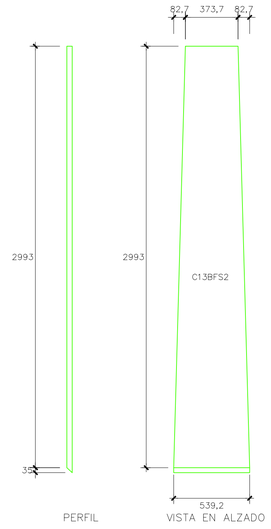
-. Vsy = Av*fys*dvy*cot(thetay) / s = 641.31 kN.
-. Vsy_lim = 0.25*fc'*bvy*dvy - Vcy = 3899.45 kN.
-. Vsy = MIN[Vsy, Vsy_lim] = 641.31 kN.
-. phiVsy = phi*Vsy = 577.18 kN.
-. phiVsy > (Vuy-phiVcy) ---> O.K !
-. Using Avy/s = Vsy / (fys*dvy*cot(thetay)) = 0.0013 m^2/m.

-. Vu = 4.488 kN.
-. Vr = 1535.483 kN.
-. Ratio = Vu / Vr = 0.003 ---> O.K !

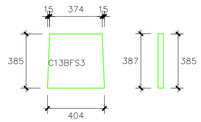
( ). Compute minimum longitudinal reinforcement by shear.
-. phia = 0.75
-. phib = 0.90
-. phiv = 0.90
-. Vs1y = MIN[Vsy, Vuy/phiv] = 4.99 kN.
-. Vs1z = MIN[Vsz, Vuz/phiv] = 4.99 kN.
-. Asy_req = [Muz/(phib*dvy) - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay)] / fy = -0.0041 m^2.
-. Asz_req = [Muy/(phib*dvz) - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz)] / fy = -0.0041 m^2.
-. As_req = MAX[Asy_req, Asz_req] = -0.0041 m^2.
-. As = 0.0261 m^2.
-. As_req < As ---> O.K !



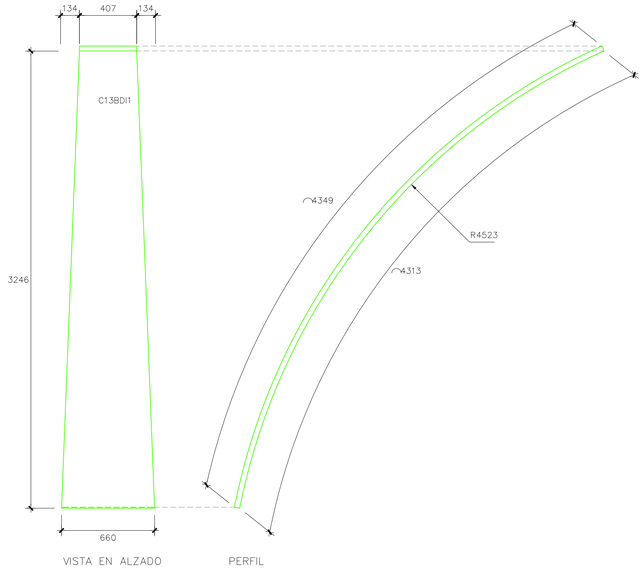
PLACAS
LATERALES
C13BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



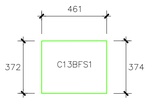
PLACAS SUPERIORES
C13BFS2
UDS. = 2
ESPESOR = 1 ½"



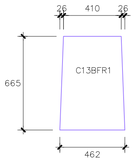
PLACAS SUPERIORES
C13BFS3
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C14BFI1
UDS. = 2
ESPESOR = 1 ½"



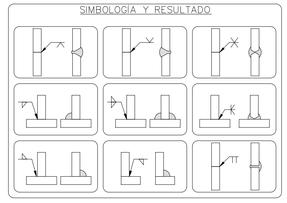
PLACAS SUPERIORES
C13BFS1
UDS. = 2
ESPESOR = 1 ½"



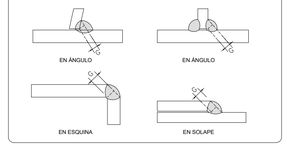
PLACAS
RIGIDIZADORAS
C13BFR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 13
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20

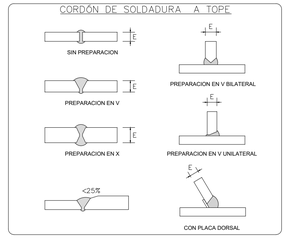
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 13
UNIDADES = 2 COLUMNAS

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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SECRETARIO DE OBRAS Y SERVICIOS
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DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
PREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. Prof.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. Prof.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 13. DESPIECE (II)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0049-00250-P-00**

ESCALA GRÁFICA: 0.2 0.6 1

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:20
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
					ACOT.: METROS

DGOT-20-EST-III-0049-00250-P-00

	PLANOS	
1	DGOT-20-EST-III-0004-00205-P-00	ÍNDICE Y NOTAS GENERALES INDICE DE PLANOS
2	DGOT-20-EST-III-0005-00206-P-00	ÍNDICE Y NOTAS GENERALES NOTAS GENERALES
3	DGOT-20-EST-III-0006-00207-P-00	DEFINICIÓN GENERAL PLANTA Y DESARROLLO LONGITUDINAL
4	DGOT-20-EST-III-0007-00208-P-00	CABALLETE 1 GEOMETRÍA Y REPLANTEO
5	DGOT-20-EST-III-0008-00209-P-00	CABALLETE 2 GEOMETRÍA Y REPLANTEO
6	DGOT-20-EST-III-0009-00210-P-00	CABALLETE 1 Y 2 DESPIECE DE BASTIDOR
7	DGOT-20-EST-III-0010-00211-P-00	CABALLETES CABALLETE 1 REFUERZO
8	DGOT-20-EST-III-0011-00212-P-00	CABALLETES CABALLETE 2 REFUERZO
9	DGOT-20-EST-III-0012-00213-P-00	CIMENTACIONES DE COLUMNAS REPLANTEO
10	DGOT-20-EST-III-0013-00214-P-00	CIMENTACIONES DE COLUMNAS GEOMETRÍA
11	DGOT-20-EST-III-0014-00215-P-00	CIMENTACIONES DE COLUMNAS REFUERZO DE PILAS
12	DGOT-20-EST-III-0015-00216-P-00	CIMENTACIONES DE COLUMNAS REFUERZO DE ENCEPADOS
13	DGOT-20-EST-III-0016-00217-P-00	CIMENTACIONES DE COLUMNAS COLUMNAS 2, 6, 14 Y 15 DEFINICIÓN DE TRABE DE ATADO
14	DGOT-20-EST-III-0017-00218-P-00	CIMENTACIONES DE COLUMNAS REFUERZO DE PLINTOS
15	DGOT-20-EST-III-0018-00219-P-00	COLUMNAS METÁLICAS PLACAS DE ANCLAJE A CIMENTACIONES (I)
16	DGOT-20-EST-III-0019-00220-P-00	COLUMNAS METÁLICAS PLACAS DE ANCLAJE A CIMENTACIONES (II)
17	DGOT-20-EST-III-0020-00221-P-00	COLUMNAS METÁLICAS PLACAS DE ANCLAJE A CIMENTACIONES (III)
18	DGOT-20-EST-III-0021-00222-P-00	COLUMNAS METÁLICAS PLACAS DE ANCLAJE A CIMENTACIONES (IV)
19	DGOT-20-EST-III-0022-00223-P-00	COLUMNAS METÁLICAS PLACAS DE ANCLAJE A CIMENTACIONES (V)
20	DGOT-20-EST-III-0023-00224-P-00	COLUMNAS METÁLICAS PLACAS DE ANCLAJE A CIMENTACIONES (VI)
21	DGOT-20-EST-III-0024-00225-P-00	COLUMNAS METÁLICAS COLUMNA 1 VISTAS
22	DGOT-20-EST-III-0025-00226-P-00	COLUMNAS METÁLICAS COLUMNA 1 DESPICE (I)
23	DGOT-20-EST-III-0026-00227-P-00	COLUMNAS METÁLICAS COLUMNA 1 DESPICE (II)
24	DGOT-20-EST-III-0027-00228-P-00	COLUMNAS METÁLICAS COLUMNA 2 VISTAS
25	DGOT-20-EST-III-0028-00229-P-00	COLUMNAS METÁLICAS COLUMNA 2 DESPICE (I)
26	DGOT-20-EST-III-0029-00230-P-00	COLUMNAS METÁLICAS COLUMNA 2 DESPICE (II)
27	DGOT-20-EST-III-0030-00231-P-00	COLUMNAS METÁLICAS COLUMNA 3 VISTAS Y DESPIECE
28	DGOT-20-EST-III-0031-00232-P-00	COLUMNAS METÁLICAS COLUMNA 4 VISTAS Y DESPIECE
29	DGOT-20-EST-III-0032-00233-P-00	COLUMNAS METÁLICAS COLUMNA 5 VISTAS Y DESPIECE
30	DGOT-20-EST-III-0033-00234-P-00	COLUMNAS METÁLICAS COLUMNA 6 VISTAS
31	DGOT-20-EST-III-0034-00235-P-00	COLUMNAS METÁLICAS COLUMNA 6 DESPICE (I)
32	DGOT-20-EST-III-0035-00236-P-00	COLUMNAS METÁLICAS COLUMNA 6 DESPICE (II)
33	DGOT-20-EST-III-0036-00237-P-00	COLUMNAS METÁLICAS COLUMNA 7 VISTAS Y DESPIECE (I)
34	DGOT-20-EST-III-0037-00238-P-00	COLUMNAS METÁLICAS COLUMNA 7 DESPICE (II)
35	DGOT-20-EST-III-0038-00239-P-00	COLUMNAS METÁLICAS COLUMNA 8 VISTAS Y DESPIECE (I)
36	DGOT-20-EST-III-0039-00240-P-00	COLUMNAS METÁLICAS COLUMNA 8 DESPIECE (II)
37	DGOT-20-EST-III-0040-00241-P-00	COLUMNAS METÁLICAS COLUMNA 9 VISTAS Y DESPIECE
38	DGOT-20-EST-III-0041-00242-P-00	COLUMNAS METÁLICAS COLUMNA 10 VISTAS Y DESPIECE
39	DGOT-20-EST-III-0042-00243-P-00	COLUMNAS METÁLICAS COLUMNA 11 VISTAS Y DESPIECE (I)
40	DGOT-20-EST-III-0043-00244-P-00	COLUMNAS METÁLICAS COLUMNA 11 DESPIECE (II)
41	DGOT-20-EST-III-0044-00245-P-00	COLUMNAS METÁLICAS COLUMNA 12 VISTAS
42	DGOT-20-EST-III-0045-00246-P-00	COLUMNAS METÁLICAS COLUMNA 12 DESPICE (I)
43	DGOT-20-EST-III-0046-00247-P-00	COLUMNAS METÁLICAS COLUMNA 12 DESPICE (II)
44	DGOT-20-EST-III-0047-00248-P-00	COLUMNAS METÁLICAS COLUMNA 13 VISTAS
45	DGOT-20-EST-III-0048-00249-P-00	COLUMNAS METÁLICAS COLUMNA 13 DESPICE (I)
46	DGOT-20-EST-III-0049-00250-P-00	COLUMNAS METÁLICAS COLUMNA 13 DESPICE (III)
47	DGOT-20-EST-III-0050-00251-P-00	COLUMNAS METÁLICAS COLUMNA 14 VISTAS
48	DGOT-20-EST-III-0051-00252-P-00	COLUMNAS METÁLICAS COLUMNA 14 DESPICE (I)
49	DGOT-20-EST-III-0052-00253-P-00	COLUMNAS METÁLICAS COLUMNA 14 DESPICE (II)
50	DGOT-20-EST-III-0053-00254-P-00	COLUMNAS METÁLICAS COLUMNA 15 VISTAS
51	DGOT-20-EST-III-0054-00255-P-00	COLUMNAS METÁLICAS COLUMNA 15 DESPICE (I)
52	DGOT-20-EST-III-0055-00256-P-00	COLUMNAS METÁLICAS COLUMNA 15 DESPICE (II)
53	DGOT-20-EST-III-0056-00257-P-00	COLUMNAS METÁLICAS COLUMNA 16 VISTAS
54	DGOT-20-EST-III-0057-00258-P-00	COLUMNAS METÁLICAS COLUMNA 16 DESPICE (I)
55	DGOT-20-EST-III-0058-00259-P-00	COLUMNAS METÁLICAS COLUMNA 16 DESPICE (II)
56	DGOT-20-EST-III-0059-00260-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 1. DESPIECE
57	DGOT-20-EST-III-0060-00261-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 2. DESPIECE
58	DGOT-20-EST-III-0061-00262-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 3, 4, Y 5. DESPIECE
59	DGOT-20-EST-III-0062-00263-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 6. DESPIECE
60	DGOT-20-EST-III-0063-00264-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 7. DESPIECE

	PLANOS	
61	DGOT-20-EST-III-0064-00265-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 8. DESPIECE
62	DGOT-20-EST-III-0065-00266-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 9 Y 10. DESPIECE
63	DGOT-20-EST-III-0066-00267-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 11. DESPIECE
64	DGOT-20-EST-III-0067-00268-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 12. DESPIECE
65	DGOT-20-EST-III-0068-00269-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 13.DESPIECE
66	DGOT-20-EST-III-0069-00270-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 14. DESPIECE
67	DGOT-20-EST-III-0070-00271-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 15. DESPIECE
68	DGOT-20-EST-III-0071-00272-P-00	COLUMNAS METÁLICAS REMATES ESTÉTICOS SUPERIORES COLUMNA 16. DESPIECE
69	DGOT-20-EST-III-0072-00273-P-00	TABLERO GEOMETRÍA Y REPLANTEO (I)
70	DGOT-20-EST-III-0073-00274-P-00	TABLERO GEOMETRÍA Y REPLANTEO (II)
71	DGOT-20-EST-III-0074-00275-P-00	TABLERO GEOMETRÍA Y REPLANTEO (III)
72	DGOT-20-EST-III-0075-00276-P-00	TABLERO GEOMETRÍA Y REPLANTEO (IV)
73	DGOT-20-EST-III-0076-00277-P-00	TABLERO ESTRUCTURA METÁLICA SECCIONES TIPO (I)
74	DGOT-20-EST-III-0077-00278-P-00	TABLERO ESTRUCTURA METÁLICA SECCIONES TIPO (II)
75	DGOT-20-EST-III-0078-00279-P-00	TABLERO ESTRUCTURA METÁLICA SECCIONES TIPO (III)
76	DGOT-20-EST-III-0079-00280-P-00	TABLERO ESTRUCTURA METÁLICA SECCIONES TIPO (IV)
77	DGOT-20-EST-III-0080-00281-P-00	TABLERO ESTRUCTURA METÁLICA CABECERO
78	DGOT-20-EST-III-0081-00282-P-00	TABLERO ESTRUCTURA METÁLICA TRAVIESAS PRINCIPALES (I)
79	DGOT-20-EST-III-0082-00283-P-00	TABLERO ESTRUCTURA METÁLICA TRAVIESAS PRINCIPALES (II)
80	DGOT-20-EST-III-0083-00284-P-00	TABLERO ESTRUCTURA METÁLICA TRAVIESAS PRINCIPALES (III)
81	DGOT-20-EST-III-0084-00285-P-00	TABLERO ESTRUCTURA METÁLICA TRAVIESAS PRINCIPALES (IV)
82	DGOT-20-EST-III-0085-00286-P-00	TABLERO ESTRUCTURA METÁLICA TRAVIESAS PRINCIPALES (V)
83	DGOT-20-EST-III-0086-00287-P-00	TABLERO ESTRUCTURA METÁLICA TRAVIESAS SECUNDARIAS
84	DGOT-20-EST-III-0087-00288-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (I)
85	DGOT-20-EST-III-0088-00289-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (II)
86	DGOT-20-EST-III-0089-00290-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (III)
87	DGOT-20-EST-III-0090-00291-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (IV)
88	DGOT-20-EST-III-0091-00292-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (V)
89	DGOT-20-EST-III-0092-00293-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (VI)
90	DGOT-20-EST-III-0093-00294-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (VII)
91	DGOT-20-EST-III-0094-00295-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN CENTRAL (VII)
92	DGOT-20-EST-III-0095-00296-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN CENTRAL
93	DGOT-20-EST-III-0096-00297-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (I)
94	DGOT-20-EST-III-0097-00298-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (II)
95	DGOT-20-EST-III-0098-00299-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (III)
96	DGOT-20-EST-III-0099-00300-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (IV)
97	DGOT-20-EST-III-0100-00301-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (V)
98	DGOT-20-EST-III-0101-00302-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (VI)
99	DGOT-20-EST-III-0102-00303-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (VII)
100	DGOT-20-EST-III-0103-00304-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (VIII)
101	DGOT-20-EST-III-0104-00305-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (IX)
102	DGOT-20-EST-III-0105-00306-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (X)
103	DGOT-20-EST-III-0106-00307-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (XI)
104	DGOT-20-EST-III-0107-00308-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (XII)
105	DGOT-20-EST-III-0108-00309-P-00	TABLERO ESTRUCTURA METÁLICA CAJÓN NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (XIII)
106	DGOT-20-EST-III-0109-00310-P-00	TABLREO LASTRE EN CLARO 1
107	DGOT-20-EST-III-0110-00311-P-00	TABLERO TABLETAS PREFABRICADAS PLANTA GENERAL
108	DGOT-20-EST-III-0111-00312-P-00	TABLERO TABLETAS PREFABRICADAS GEOMETRÍA Y REFUERZO (I)
109	DGOT-20-EST-III-0112-00313-P-00	TABLERO TABLETAS PREFABRICADAS GEOMETRÍA Y REFUERZO (II)
110	DGOT-20-EST-III-0113-00314-P-00	TABLERO LOSA SUPERIOR REFUERZO Y JUNTAS DE DILATACIÓN
111	DGOT-20-EST-III-0114-00315-P-00	PROCESO CONSTRUCTIVO (I)
112	DGOT-20-EST-III-0115-00316-P-00	PROCESO CONSTRUCTIVO (II)
113	DGOT-20-EST-III-0159-00360-M-00	MEMORIA DE CÁLCULO ESTRUCTURAL DE LA CALZADA FLOTANTE

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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SECRETARIO DE OBRAS Y SERVICIOS
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SUBSECRETARÍA DE INFRAESTRUCTURA

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DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1456

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0455

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

ÍNDICE Y NOTAS GENERALES
ÍNDICE DE PLANOS

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

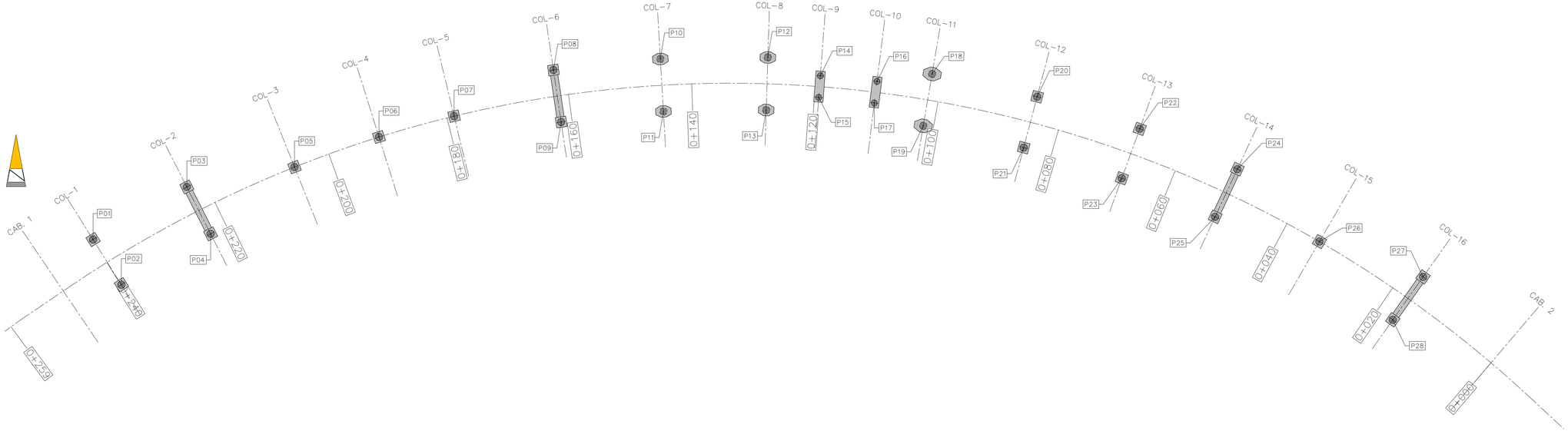
PLANO No: **DGOT-20-EST-III-0004-00205-P-00**

ESCALA GRÁFICA:

	FECHA	DEPTO.	NOMBRE	FIRMA
DISEÑÓ		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: ---
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0004-00205-P-00



CIMENTACIONES DE COLUMNAS
PLANTA
ESCALA 1:350

REPLANTEO DE CIMENTACIONES DE COLUMNAS

COLUMNA	PILA	X	Y
COL - 1	P01	479 443.767	2 147 107.837
	P02	479 448.342	2 147 100.534
COL - 2	P03	479 458.922	2 147 116.341
	P04	479 462.771	2 147 108.763
COL - 3	P05	479 476.328	2 147 119.562
COL - 4	P06	479 489.984	2 147 124.426
COL - 5	P07	479 502.122	2 147 127.795
COL - 6	P08	479 518.175	2 147 135.255
	P09	479 519.429	2 147 126.848
COL - 7	P10	479 535.458	2 147 137.045
	P11	479 535.954	2 147 128.559
COL - 8	P12	479 552.831	2 147 137.281
	P13	479 552.566	2 147 128.785
COL - 9	P14	479 561.319	2 147 134.323
	P15	479 561.053	2 147 130.833
COL - 10	P16	479 570.476	2 147 133.404
	P17	479 570.043	2 147 129.931
COL - 11	P18	479 579.382	2 147 134.616
	P19	479 577.953	2 147 126.237
COL - 12	P20	479 596.362	2 147 130.932
	P21	479 594.189	2 147 122.715
COL - 13	P22	479 612.944	2 147 125.744
	P23	479 610.045	2 147 117.754
COL - 14	P24	479 628.718	2 147 119.223
	P25	479 625.128	2 147 111.518
COL - 15	P26	479 641.990	2 147 107.510
COL - 16	P27	479 658.746	2 147 101.804
	P28	479 653.838	2 147 094.864

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CISE-0085

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CIMENTACIONES DE COLUMNAS
REPLANTEO

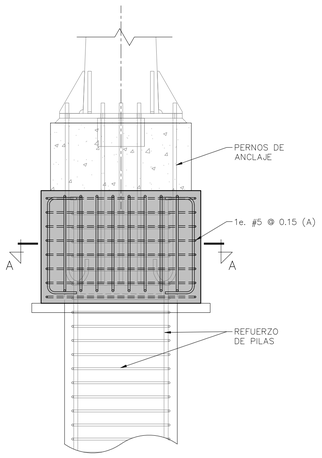
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0012-00213-P-00

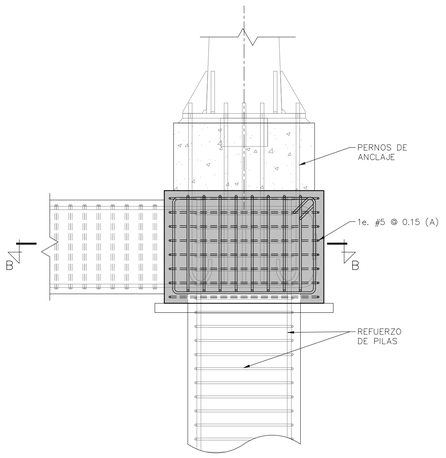
ESCALA GRÁFICA
0 0.5 0.8 1.5 2

FECHA:	DEPTO.	NOMBRE	FIRMA	
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		ESCALA: 1:50
	ESTRUCTURA	M.I. ARQEL RAMOS CARRETANA		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
	GEOTÉCNIA	M.I. FRANCISCO PANIAGUA MEDINA		ACOT: METROS

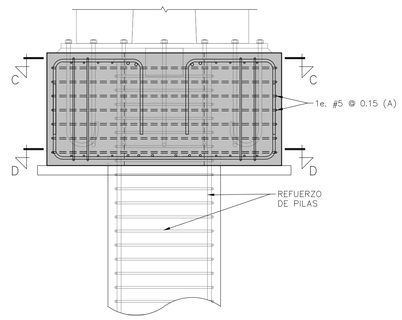
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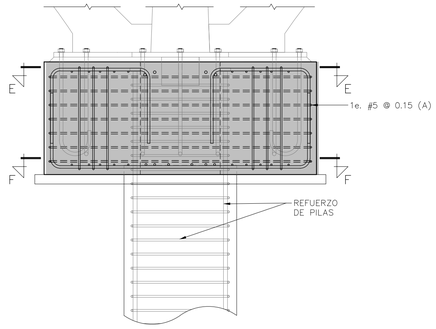
ALZADO



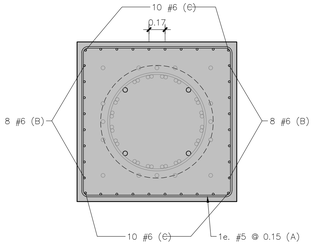
ALZADO



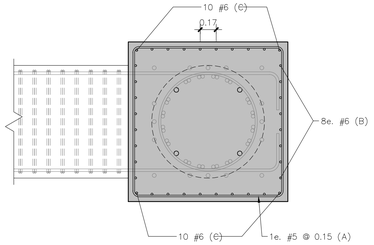
ALZADO



ALZADO



SECCIÓN A–A

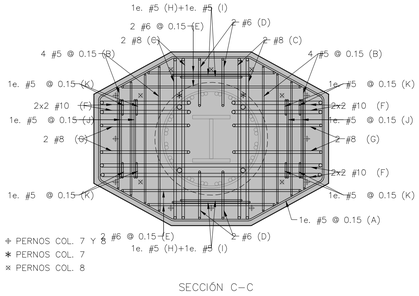


SECCIÓN B–B

SIN TRABE DE ATADO

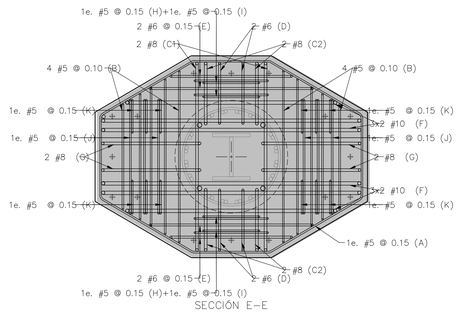
CON TRABE DE ATADO

CIMENTACIÓN TIPO C–I
REFUERZO DE ENCEPADO
ESCALA 1:30

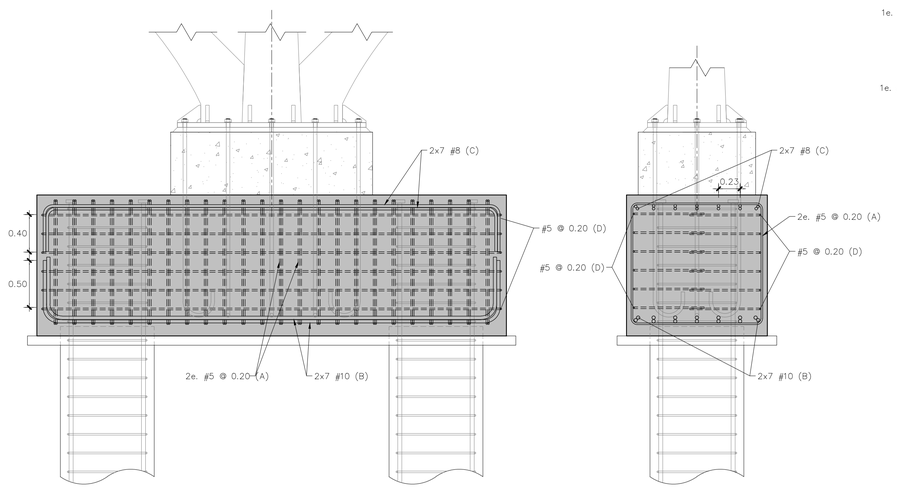


+ PERNOS COL. 7 Y 8
∗ PERNOS COL. 7
× PERNOS COL. 8

SECCIÓN C–C



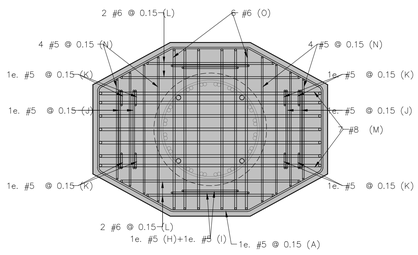
SECCIÓN E–E



VISTA TRANSVERSAL

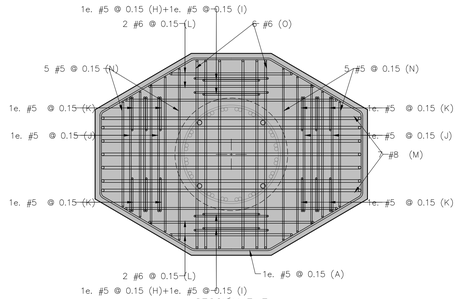
VISTA LONGITUDINAL

CIMENTACIÓN TIPO C–II (COLUMNAS 9 Y 10)
REFUERZO DE ENCEPADO
ESCALA 1:30



SECCIÓN D–D

CIMENTACIÓN COLUMNAS 7 Y 8
REFUERZO DE ENCEPADO
ESCALA 1:30



SECCIÓN F–F

CIMENTACIÓN COLUMNA 11
REFUERZO DE ENCEPADO
ESCALA 1:30

CONCRETO

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES EN EL PLANO DE NOTAS GENERALES.

ACERO DE REFUERZO

- CONSULTAR LONGITUDES DE TRASLAPE, ANCLAJES Y OTROS DETALLES EN EL PLANO DE NOTAS GENERALES.
- LOS EMPALMES DE VARILLAS #10 Y#12 SE RESOLVERÁN MEDIANTE CONECTORES MECÁNICOS, SE ATENDERÁ A LAS ESPECIFICACIONES DEL FABRICANTE PARA GARANTIZAR QUE EL CONECTOR SELECCIONADO PERMITA LA TRANSFERENCIA DE LA CARGA MÁXIMA ENTRE LAS VARILLAS A EMPALMAR.
- EL ANCLAJE DE LAS VARILLAS DE REFUERZO PRINCIPAL DE LAS PILAS DENTRO DEL ENCEPADO SE RESOLVERÁ EMPLEANDO VARILLAS CON CABEZA EN T, CON ANCLAJES MECÁNICOS TIPO TERMINATOR O SIMILAR. SE ATENDERÁ A QUE EL SISTEMA EMPLEADO GARANTICE LA TRANSMISIÓN DE LAS CARGAS DEL CONCRETO EN LA SECCIÓN FINAL DE LAS VARILLAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSTORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.60m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

BEDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR ÚNICO
FREBEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CPD-7449

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CPD-3089

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CIMENTACIONES DE COLUMNAS
REFUERZO DE ENCEPADOS

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0015-00216-P-00**

ESCALA GRÁFICA: 0 0.3 0.9 1.5

REVISIÓN	FECHA:	DISTO:	NOMBRE:	FIRMA:	MOD: 1:30
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARQEL RAMOS CARRETRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
		GEOTECNIA	M.I. FRANCISCO PANIAGUA MEDINA		ACOT: METROS

DGOT-20-EST-III-0015-00216-P-00

NOTAS GENERALES:

- EN TÉRMINOS GENERALES Y SALVO INDICACIÓN EN CONTRA, LAS DIMENSIONES SE EXPRESAN EN METROS. EN LOS PLANOS ESPECÍFICOS DE ESTRUCTURA METÁLICA SE EXPRESARÁN EN MILÍMETROS.
- LAS COORDENADAS DE REPLANTEO Y LAS ELEVACIONES ALTIMÉTRICAS SE EXPRESAN EN METROS.
- LAS COTAS RIGEN SOBRE EL DIBUJO.
- ANTES DE MONTAR LA ESTRUCTURA, SE DEBERÁN VERIFICAR LOS NIVELES, POSICIONES Y UBICACIONES DE LOS ELEMENTOS ESTRUCTURALES.

ESPECIFICACIONES:

SERÁ DE APLICACIÓN LAS NORMAS SIGUIENTES:

- BRIDGE DESIGN SPECIFICATIONS – AASHTO CON SU METODOLOGÍA LRFD.
- REGLAMENTO DE CONSTRUCCIONES DEL DISTRITO FEDERAL – RCDF.
- NORMAS TÉCNICAS COMPLEMENTARIAS APARTADO DISEÑO Y CONSTRUCCIÓN DE CIMENTACIONES.
- MANUAL DE OBRAS CIVILES (MDOC)– DISEÑO SÍSMICO 2015 – COMISIÓN FEDERAL DE ELECTRICIDAD.
- REQUISITOS DE REGLAMENTO PARA CONCRETO ESTRUCTURAL – ACI 318S–19.
- STEEL CONSTRUCTION MANUAL – AMERICAN INSTITUTE OF STEEL CONSTRUCTION AISC.
- MANUAL DE CONSTRUCCIÓN EN ACERO – INSTITUTO MEXICANO DE LA CONSTRUCCIÓN EN ACERO, A.C.
- CRITERIOS GENERALES DE ANÁLISIS Y DISEÑO – SECCIÓN C – CAPÍTULO 2. ACCIONES – COMISIÓN FEDERAL DE ELECTRICIDAD.
- PROYECTOS DE NUEVOS PUENTES Y ESTRUCTURAS SIMILARES – 004 VIENTO – SECRETARÍA DE COMUNICACIONES Y TRANSPORTES SCT.

CIMBRA:

- LA CIMBRA DEBERÁ ESTAR COMPLETAMENTE LIMPIA, A PLOMO O NIVELADA.
- EL LUBRICADO DEBERÁ HACERSE ANTES DE COLOCAR EL ARMADO.

CONCRETO:

- SE USARÁ CONCRETO CLASE 1 CON PESO VOLUMÉTRICO MAYOR A 2200 kg/m3.
- EL CONCRETO SERÁ PREMEZCLADO.
- EL TAMAÑO MÁXIMO DEL AGREGADO GRUESO SERÁ DE 2 cm.
- RESISTENCIA MÍNIMA DEL CONCRETO A 28 DÍAS:
  - PILAS: 300 kg/cm2
  - CIMENTACIÓN DE CABALLETES: 300 kg/cm2
  - ALZADOS DE CABALLETES: 300 kg/cm2
  - ENCEPADOS Y PLINTOS DE COLUMNAS: 300 kg/cm2
  - PRELOSAS PREFABRICADAS: 300 kg/cm2
  - LOSA COLADA IN SITU: 300 kg/cm2
- RECUBRIMIENTOS LIBRES:
  - PILAS COLADAS CONTRA EL TERRENO: 75mm
  - CIMENTACIÓN DE CABALLETES: 50mm
  - ALZADOS DE CABALLETES: 50mm
  - ENCEPADOS Y PLINTOS DE COLUMNAS: 50mm
  - PRELOSAS PREFABRICADAS: 20mm
  - LOSA COLADA IN SITU: 25mm (CARA INFERIOR, CONTRA PRELOSA)

    40mm (CARA SUPERIOR)
  - LOS RECUBRIMIENTOS DEBERÁN SER VERIFICADOS ANTES Y DURANTE EL COLADO.
- LA PLANTILLA SERÁ DE CONCRETO f'c = 100 kg/cm2
- EL REVENIMIENTO NOMINAL DEL CONCRETO NO SERÁ MAYOR DE 12.0 cm ± 2.50 cm
  - EN CASO DE QUE EL PROCEDIMIENTO CONSTRUCTIVO REQUIERA UN REVENIMIENTO MAYOR, SE PODRÁ AMPLIAR MEDIANTE EL USO DE ADITIVOS Y FLUIDIFICANTES QUE NO AFECTEN LA RESISTENCIA NI LAS PROPIEDADES ELÁSTICAS DEL CONCRETO.
- LA COMPACTACIÓN DEL CONCRETO SE REALIZARÁ POR VIBRACIÓN INTERNA CON UN VIBRADOR MECÁNICO O UN VIBRADOR DE FLECHA FLEXIBLE SEGÚN LO MENCIONADO EN EL DOCUMENTO ACI–309R–05.
- EL MUESTREO DE CONCRETO MÍNIMO SE REALIZARÁ CON BASE EN LA SIGUIENTE DESCRIPCIÓN:
  - o REVENIMIENTO:

    UNA VEZ POR CADA ENTREGA, SI ES PREMEZCLADO.
  - o PRUEBAS A COMPRESIÓN:

    LOS ENSAYOS DEBERÁN REALIZARSE A LOS 7, 14 Y 28 DÍAS DE HABER REALIZADO EL COLADO.
  - o PESO VOLUMÉTRICO:

    UNA VEZ POR CADA DÍA DE COLADO, PERO NO MENOS DE UNA VEZ POR CADA 20 m3 DE CONCRETO.
- CONSIDERAR CURADO DE CONCRETO (CURACRETO INCOLORO T1CA O SIMILAR) TAN PRONTO DESAPAREZCA EL AGUA DE SANGRADO DEL CONCRETO O MORTERO.
- SE RECOMIENDA QUE EL COLADO DE CADA ELEMENTO SEA MONOLÍTICO. EN CASO DE NO PODER REALIZAR UN COLADO MONOLÍTICO SE RECOMIENDA PICAR LA SUPERFICIE DE CONCRETO ENDURECIDO DEJANDO UNA RUGOSIDAD DE ± 10 mm COMO MÍNIMO, RETIRAR EL MATERIAL SUELTO O MAL ADHERIDO (QUE PUEDA AFECTAR LA LIGA CON EL CONCRETO FRESCO) Y HUMEDECER LA SUPERFICIE CADA 6 HORAS, DURANTE 24 HORAS PREVIAS AL COLADO. PREVIAMENTE AL NUEVO COLADO, SE COLOCARÁ A LO LARGO DE LA JUNTA ADHECON Y UN CORDÓN EXPANSIVO ATENDIENDO LAS ESPECIFICACIONES DEL FABRICANTE.

ACERO ESTRUCTURAL:

- ESTRUCTURA METÁLICA ACERO:

  ELEMENTOS ESTRUCTURALES: ASTM A709 GR. 50.
- PARA LA SOLDADURA SE UTILIZARÁN ELECTRODOS DE LA SERIE E–70.
- LA ESTRUCTURA METÁLICA DEBE ESTAR PROTEGIDA POR UNA CAPA DE RECUBRIMIENTO ANTICORROSIVO, MÁS UNA CAPA DE PINTURA. PREVIO AL PROCESO DE PINTADO LA SUPERFICIE DEBE ESTAR COMPLETAMENTE LIMPIA. TODAS LAS PIEZAS SE DEBERÁN CUBRIR EN TALLER CON PINTURA ANTICORROSIVA, EXCEPTO EN LAS PARTES DONDE SE APLIQUE SOLDADURA DE CAMPO POR EL PROCESO CONSTRUCTIVO.
- LA ESTRUCTURA METÁLICA DEBE CUMPLIR LAS ESPECIFICACIONES DEL □AMERICAN INSTITUTE OF STEEL CONSTRUCTION□ (AISC) Y DEL □AMERICAN WELDING SOCIETY□ (AWS).
- PARA LAS UNIONES SOLDADAS SE DEBERÁ CUMPLIR CON LAS ESPECIFICACIONES DE LA AWS, EN ESPECIAL LOS DOCUMENTOS AWS D1.1 Y AWS D1.5.
- TODAS LAS SOLDADURAS SE HARÁN POR OBREROS CALIFICADOS.
- TODAS LAS SOLDADURAS SE INDICAN EN MILÍMETROS.
- ANTES DE PROCEDER A LA FABRICACIÓN, DEBERÁN ELABORARSE LOS PLANOS DE TALLER Y SER REVISADOS Y APROBADOS.
- LOS SÍMBOLOS EMPLEADOS EN LA SOLDADURA SON:



- LAS SOLDADURAS SE DEBERÁN HACER EN TALLER EXCEPTO EN LAS CUALES SE INDIQUE SOLDADURA DE CAMPO POR EL PROCESO CONSTRUCTIVO.
- SALVO INDICACIÓN EN CONTRA EN LOS PLANOS CORRESPONDIENTES, TODAS LAS SOLDADURAS SERÁN:
  - UNIÓN DE PLACAS PARA FORMACIÓN DE SECCIONES EN CAJÓN (TABLERO Y COLUMNAS):

    SE UNIRÁN LAS CHAPAS ENTRE SÍ PARA LA FORMACIÓN DE SECCIONES EN CAJÓN MEDIANTE SOLDADURA A TOPE, PREVIO BISELAMIENTO DE PLACAS.
  - UNIONES DE LAS SECCIONES DEL TABLERO ENTRE SÍ:

    SE REALIZARÁN LAS UNIONES ENTRE TRAMOS O PIEZAS DEL TABLERO MEDIANTE SOLDADURA A TOPE, PREVIO BISELAMIENTO DE PLACAS.
  - UNIONES DE LAS SECCIONES DE LAS COLUMNAS ENTRE SÍ:

    SE REALIZARÁN LAS UNIONES ENTRE TRAMOS O PIEZAS DE LAS COLUMNAS MEDIANTE SOLDADURA A TOPE, PREVIO BISELAMIENTO DE PLACAS.
  - UNIONES ENTRE TABLERO Y COLUMNAS:

    SE REALIZARÁN LAS UNIONES DEL TABLERO A LOS TRAMOS ESTRUCTURALES DE LAS RAMAS DE COLUMNAS MEDIANTE SOLDADURA DEL CONTORNO DE LA SUPERFICIE DE CONTACTO A TOPE, PREVIO BISELAMIENTO DE PLACAS.

    LOS TRAMOS DE ACABADO ESTÉTICO DE LAS COLUMNAS SE UNIRÁN AL CONJUNTO ESTRUCTURAL MEDIANTE SOLDADURA EN FILETE POR EL LADO VISTO DE LA PLACA Y CON UN ESPESOR DE CORDÓN DE SOLDADURA DE 0.7 VECES Tmin, SIENDO Tmin EL ESPESOR DE LA PLACA MÁS DELGADA.
  - UNIONES DE LA BASE DE LAS COLUMNAS A LA PLACA DE ANCLAJE Y SUS RIGIDIZADORES:

    SE UNIRÁ LA SECCIÓN DE ARRANQUE DE LA COLUMNA A LA PLACA DE ANCLAJE MEDIANTE SOLDADURA A TOPE, PREVIO BISELAMIENTO DE LAS PLACAS. SERÁ ESTE CRITERIO DE APLICACIÓN PARA LAS PLACAS PERIMETRALES DE LA COLUMNA, NO RESULTANDO NECESARIO SOLDAR PLACAS INTERMEDIAS (CUANDO EXISTAN).

    SE UNIRÁN LAS CARTELAS DE RIGIDIZACIÓN (CUANDO EXISTAN) A LA PLACA DE ANCLAJE Y A LAS PLACAS DE LA COLUMNA MEDIANTE SOLDADURA EN FILETE POR AMBOS LADOS DE LA PLACA DE RIGIDIZACIÓN Y CON UN ESPESOR, PARA AMBOS CORDONES, DE 0.7 VECES Tmin, SIENDO Tmin EL ESPESOR DE LA PLACA MÁS DELGADA.
  - UNIONES DE LOS RIGIDIZADORES/DIAFRAGMAS INTERNOS:

    SE UNIRÁN A TODAS LAS CHAPAS PERIMETRALES DE LA SECCIÓN, ASÍ COMO A RIGIDIZADORES O DIAFRAGMAS ADYACENTES MEDIANTE SOLDADURA A TOPE PREVIO BISELAMIENTO DE PLACA. ALTERNATIVAMENTE, SE PUEDE PLANTEAR SOLDADURA EN FILETE POR AMBOS LADOS DE LA PLACA Y CON UN ESPESOR, PARA AMBOS CORDONES, DE 0.7 VECES Tmin, SIENDO Tmin EL ESPESOR DE LA PLACA MÁS DELGADA.
- TODAS LAS SOLDADURAS DE PENETRACIÓN COMPLETA SE DEBERÁN REALIZAR DE ACUERDO CON UNA SOLDADURA CALIFICADA POR EL AWS.
- DONDE SE DEBAN UNIR MEDIANTE SOLDADURA PLACAS CURVAS CONTRA PLACAS RECTAS (ZONAS DE ÓCULOS EN TABLERO O PLACAS INFERIORES DE RAMAS EN COLUMNAS), SE RELLENARÁ MEDIANTE SOLDADURA Y SE SUAVIZARÁ CON AMOLADORA, EL QUIEBRO RESULTANTE A PARTIR DE LA UNIÓN ESTRICTA, DE MODO QUE PARA EL ACABADO FINAL SE PERCIBA VISUALMENTE UNA TRANSICIÓN SUAVE

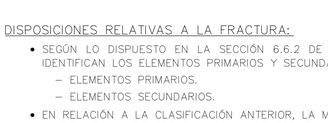
ACERO DE REFUERZO:

- SE TENDRÁ ESPECIAL CUIDADO EN LA LIMPIEZA DE LAS VARILLAS PARA EVITAR QUE TENGAN ÓXIDO SUELTO ANTES DEL COLADO.
- SE USARÁ ACERO DE REFUERZO CON UNA RESISTENCIA FY = 4200 kg/cm2, EXCEPTO EL ALAMBRÓN (#2), EL CUAL SERÁ fy = 2300 kg/cm2.
- LAS LONGITUDES DE ANCLAJE Y TRASLAPE SERÁN CONFORMES A AASHTO LRFB BDS (9TH EDITION – 2020) SEGÚN INDICADO EN LA TABLA.

fy = 4200 kg/cm2 fc = 300 kg/cm2	Longitud de anclaje				Longitud de traslape (Lt)	
	Anclaje prolongación recta		Anclaje con gancho			
Bar #	Posición desfavorable	Posición favorable	Long. ancl. (Lg)	Long. gancho	Posición desfavorable	Posición favorable
#3	87	67	18	ver detalles	113	87
#4	116	89	23	ver detalles	150	116
#5	145	111	29	ver detalles	188	145
#6	174	134	35	ver detalles	226	174
#8	231	178	47	ver detalles	301	231
#10	294	226	60	ver detalles	-	-
#12	347	267	70	ver detalles	-	-

Datos en centímetros (cm)
Posición favorable: todas las varillas no horizontales y las varillas horizontales posicionadas en los 30cm inferiores de la fase de colado.
Posición desfavorable: varillas horizontales posicionadas por encima de los 30cm inferiores del colado.

DETALLES DE REFUERZO



#	r cm	Lt cm	Lg cm	L1 cm	L2 cm	L3 cm	L4 cm
3	3.5			5	12	4	10
4	4.5			7	15	5	13
5	6			9	19	6	16
6	7			11	23	8	20
8	9			14	30	10	--
10	14			18	38	13	--
12	21			21	46	15	--

VER DETALLES EN TABLA ADJUNTA

r=RADIO DE DOBLEZ Lt=LONGITUD DE TRASLAPE Lg=LONGITUD DE ANCLAJE A PARTIR DEL PAÑO

- LOS EMPALMES DE VARILLAS #10 Y#12 SE RESOLVERÁN MEDIANTE CONECTORES MECÁNICOS. SE ATENDERÁ A LAS ESPECIFICACIONES DEL FABRICANTE PARA GARANTIZAR QUE EL CONECTOR SELECCIONADO PERMITA LA TRANSFERENCIA DE LA CARGA MÁXIMA ENTRE LAS VARILLAS A EMPALMAR.
- CON CARÁCTER GENERAL, NO DEBERÁ TRASLAPARSE MÁS DE UNA TERCERA PARTE DEL ACERO EN UNA MISMA SECCIÓN.
- LA SEPARACIÓN INDICADA EN PLANOS PARA VARILLAS ES DE CENTRO A CENTRO.
- LAS DIMENSIONES DE GANCHOS, TRASLAPES, ETC. ESTÁN INDICADAS EN EL CUADRO DE DETALLES DE REFUERZO.
- EL ANCLAJE DE LAS VARILLAS DE REFUERZO PRINCIPAL DE LAS PILAS DENTRO DEL ENCEPADO SE RESOLVERÁ EMPLEANDO VARILLAS CON CABEZA EN T, CON ANCLAJES MECÁNICOS TIPO TERMINATOR O SIMILAR. SE ATENDERÁ A QUE EL SISTEMA EMPLEADO GARANTICE LA TRANSMISIÓN DE LAS CARGAS DEL CONCRETO A LA SECCIÓN FINAL DE LAS VARILLAS.

UNIONES ATORNILLADAS:

- SE REALIZARÁN UNIONES ATORNILLADAS PARA CONECTAR LAS TRAVIESAS SECUNDARIAS DEL TABLERO A LOS PERFILES PRINCIPALES, ASÍ COMO PARA UNIR LOS TOPES SÍSMICOS A SUS BASTIDORES.
- ELEMENTOS DE TORNILLERÍA: ASTM A490

ANCLAJES:

- SE ANCLARÁN LAS COLUMNAS DE ACERO A LOS ENCEPADOS SEGÚN SE INDICA EN PLANOS MEDIANTE BARRAS DE ANCLAJE POSICIONADAS PREVIAMENTE AL COLADO DEL CONCRETO.
- PERNOS DE ANCLAJE: ASTM A490
- ENTRE LA CARA SUPERIOR DEL PLINTO O DEL ENCEPADO DE CONCRETO Y LA CARA INFERIOR DE LAS PLACAS DE ANCLAJE DE ACERO SE PREVERÁ LA DISPOSICIÓN DE UN MORTERO DE NIVELACIÓN. SE ATENDERÁ A QUE EL MORTERO TENGA UNA RESISTENCIA SUFICIENTEMENTE ELEVADA PARA SU FIN, ASÍ COMO UNA CONSISTENCIA SUFICIENTEMENTE FLUIDA Y RETRACCIÓN COMPENSADA, CON EL OBJETIVO DE GARANTIZAR QUE LA DISPOSICIÓN DEL MORTERO NO GENERA UN PLANO DE DEBILIDAD BAJO EL ANCLAJE.
- LA PLACA DE ANCLAJE, ASÍ COMO LAS CABEZAS DE PERNOS Y SUS CORRESPONDIENTES TUERCAS Y LAS CARTELAS DE RIGIDIZACIÓN (CUANDO EXISTAN) SE PROTEGERÁN MEDIANTE LA EJECUCIÓN DE UN DADO DE PROTECCIÓN DE MORTERO CON VARILLAS #3 PARA PREVENIR LA FISURACIÓN.
- PREVIO AL COLADO DEL CONCRETO DE ENCEPADOS, SE PRESTARÁ ESPECIAL ATENCIÓN AL REPLANTEO DE LOS PERNOS DE ANCLAJE, GARANTIZANDO QUE SE ENCUENTRAN EN SU POSICIÓN CORRECTA Y QUE SE ENCUENTRAN DEBIDAMENTE ASEGURADOS PARA PREVENIR SU MOVIMIENTO DURANTE EL COLADO. PARA GARANTIZAR EL FUTURO POSICIONAMIENTO DE LAS PLACAS DE ANCLAJE DE COLUMNAS, SE RECURRIRÁ AL POSICIONAMIENTO EN LA PARTE SUPERIOR DE LOS PERNOS DE UNA PLANTILLA QUE REPLIQUE LA POSICIÓN DE LOS TALADROS EN LA PLACA DE ANCLAJE DEFINITIVA.

DISPOSICIONES RELATIVAS A LA FRACTURA:

- SEGÚN LO DISPUESTO EN LA SECCIÓN 6.6.2 DE LA AASHTO LRFD BDS, SE IDENTIFICAN LOS ELEMENTOS PRIMARIOS Y SECUNDARIOS DE LA ESTRUCTURA.
  - ELEMENTOS PRIMARIOS.
  - ELEMENTOS SECUNDARIOS.
- EN RELACIÓN A LA CLASIFICACIÓN ANTERIOR, LA MISMA SECCIÓN 6.6.2 OBLIGA A IDENTIFICAR, DENTRO DE LOS ELEMENTOS PRIMARIOS DE LA ESTRUCTURA, AQUELLOS QUE SE VEAN SOMETIDAS A UN ESTADO DE TENSIONES NETAS PARA LA COMBINACIÓN DE CARGAS DE RESISTENCIA 1. ESTOS ELEMENTOS SE CONSIDERAN COMO □ELEMENTOS DE FRACTURA CRÍTICA□(FCM: FRACTURE CRITICAL MEMBER).
  - SEGÚN LOS RESULTADOS OBTENIDOS A PARTIR DE LOS MODELOS DE CÁLCULO REALIZADOS, TODOS LOS ELEMENTOS DEL TABLERO SE PUEDEN VER SOMETIDOS A UN ESTADO DE TENSIONES NETAS PARA LA COMBINACIÓN DE CARGAS DE RESISTENCIA 1. EN LO QUE RESPECTA A LA SUBESTRUCTURA, LOS FUSTES DE LAS COLUMNAS NUNCA ALCANZAN UN ESTADO DE ESFUERZOS A TENSIÓN NETOS, PERO SÍ LO HACEN ALGUNAS DE SUS RAMAS.
- POR LO ANTERIORMENTE EXPUESTO, SE CONSIDERAN ELEMENTOS DE FRACTURA CRÍTICA LAS RAMAS DE LAS COLUMNAS Y LOS PERFILES QUE INTEGRAN EL TABLERO.

NOTAS COLISIÓN DE VEHÍCULOS

- EL DISEÑO DE LA ESTRUCTURA DE LA CALZADA PEATONAL SE REALIZA ASUMIENDO QUE SE RECTIFICARÁN LOS VIALES QUE LO REQUIERAN PARA CUMPLIR GÁLIBO VERTICAL DE 5.50 METROS; POR TANTO NO SE CONSIDERA COLISIÓN VEHICULAR CONTRA EL TABLERO EN EL DISEÑO ESTRUCTURAL. LA RECTIFICACIÓN DE LOS VIALES ES OBJETO DE DEFINICIÓN INDEPENDIENTE.
- DEL MISMO MODO, TAMPOCO SE CONSIDERA COLISIÓN VEHICULAR EN EL DISEÑO DE LAS COLUMNAS, AL CONSIDERARSE QUE QUEDARÁN DEBIDAMENTE PROTEGIDAS. LAS RECTIFICACIONES NECESARIAS PARA PROTEGER LAS COLUMNAS SON OBJETO DE DEFINICIÓN INDEPENDIENTE.

RESUMEN DE MEDICIÓN

MATERIALES	MEDICIÓN	
SUPERESTRUCTURA		
Acero estructural en placas	913999.2	kg
Acero estructural en perfiles de serie W	74827.9	kg
Concreto de f'c = 300 kg/cm^2, en:		
Losa in situ	220.5	m^3
Lastres claro 1	28.3	m^3
Acero de refuerzo de LE ≥ 4200 kg/cm^2 en:		
Losa in situ	60605.2	kg
Tableta prefabricada armada de espesor 7cm	1653.0	m^2
JUNTAS DE DILATACIÓN		
Junta de dilatación de tablero	40.0	m
APOYOS Y TOPES SÍSMICOS		
Neopreno ASTM D2240, Dureza Shore 60 (ft = 100 kg/cm)	191.0	dm^3
SUBESTRUCTURA		
Acero estructural en placas, en:		
Caballetes	1551.2	kg
Columnas	256701.2	kg
Pernos de anclaje A490	7114.5	kg
Concreto de f'c = 300 kg/cm^2, en:		
Zapatas de caballetes	319.7	m^3
Alzado de caballetes	273.3	m^3
Pilas	502.2	m^3
Encepados	76.0	m^3
Plintos	35.1	m^3
Vigas de atado	32.6	m^3
Acero de refuerzo de LE ≥ 4200 kg/cm^2 en:		
Caballetes	41536.7	kg
Pilas	161170.6	kg
Encepados y plintos	18535.9	kg
Vigas de atado	8687.6	kg
Excavación	2285.5	m^3
Plantilla concreto simple f'c = 100 kg/cm^2 e = 10cm	36.8	m^3
Lámina drenante	264.8	m^2
Tubo drenaje ranurado	151.8	m

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A. DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1450

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CORE-0855

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
ÍNDICE Y NOTAS GENERALES
NOTAS GENERALES

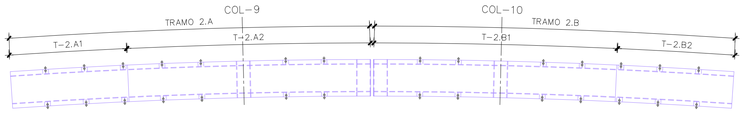
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0005-00206-P-00**

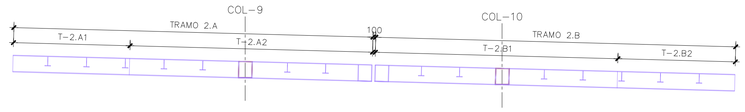
ESCALA GRÁFICA

ESCALA	FECHA	DISEÑO	NOMBRE	FIRMA	MOD.
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRÁN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		DIBUJ.
					ACOT. METROS

DGOT-20-EST-III-0005-00206-P-00



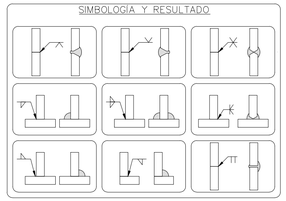
PLANTA

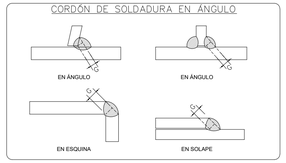


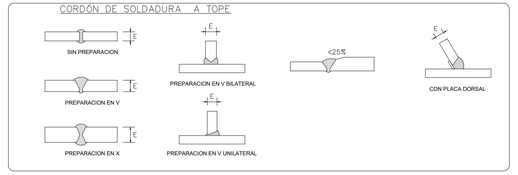
ALZADO

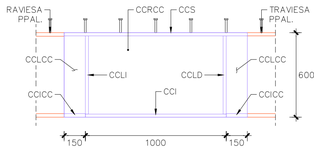
CAJÓN CENTRAL. TRAMO 2

ESCALA 1:100

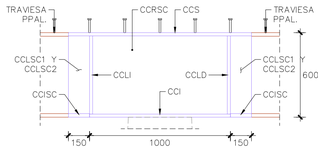




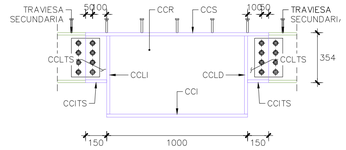




ENCUENTRO TIPO 1
ENCUENTRO CON TRAVIESA PPAL.
CENTRO DE CLARO



ENCUENTRO TIPO 2
ENCUENTRO CON TRAVIESA PPAL.
SOBRE COLUMNA



ENCUENTRO TIPO 3
ENCUENTRO CON TRAVIESA
SECUNDARIA

CAJÓN CENTRAL. SECCIONES TRANSVERSALES

ESCALA 1:20



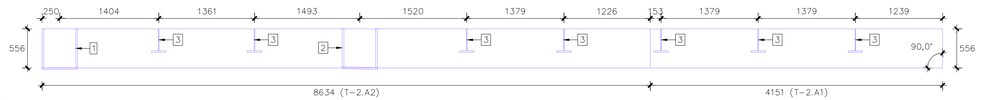
PLACA
CCS-T2A1
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCS-T2A2
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCS. PLANTA



PLACAS CCLI. PLANTA



1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

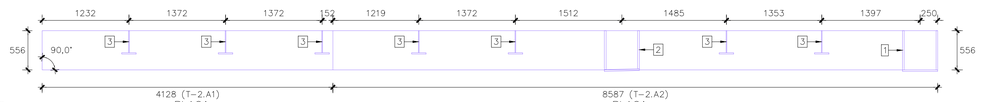
PLACA
CCLI-T2A2
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLI-T2A1
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLI. ALZADO DESARROLLADO



PLACAS CCLD. PLANTA

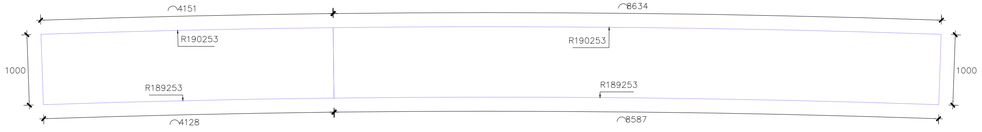


1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

PLACA
CCLD-T2A1
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLD-T2A2
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLD. ALZADO DESARROLLADO



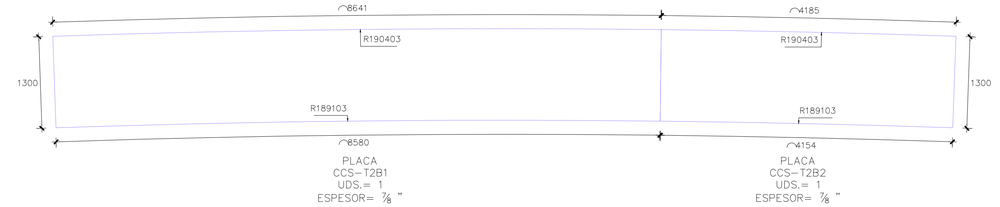
PLACA CCI-T2A1
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T2A2
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 2.A

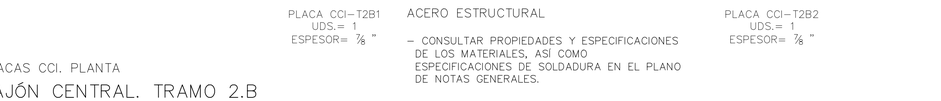
ESCALA 1:40



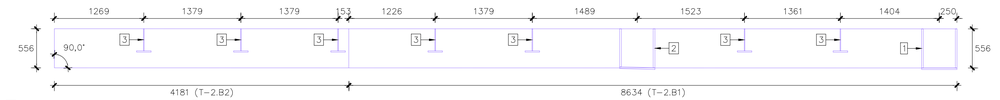
PLACA
CCS-T2B1
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCS-T2B2
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCS. PLANTA



PLACAS CCLI. PLANTA



1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

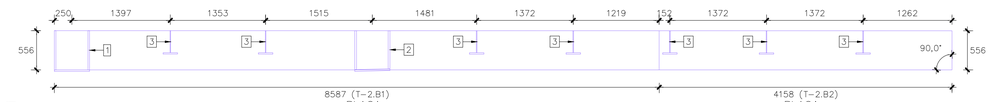
PLACA
CCLI-T2B2
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLI-T2B1
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLI. ALZADO DESARROLLADO



PLACAS CCLD. PLANTA

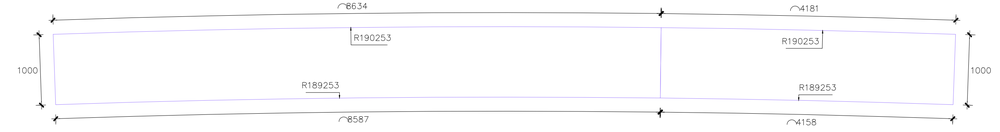


1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

PLACA
CCLD-T2B1
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLD-T2B2
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLD. ALZADO DESARROLLADO



PLACA CCI-T2B1
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T2B2
UDS.= 1
ESPESOR= 7/8 "

ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 2.B

ESCALA 1:40

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN-AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA
CAJÓN CENTRAL (V)

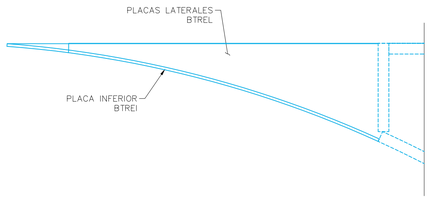
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

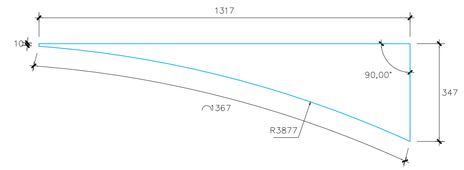
PLANO No.: DGOT-20-EST-III-0091-00292-P-00

ESCALA GRÁFICA: 0 4 12 7 4

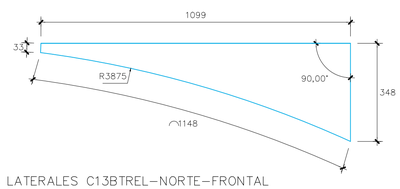
ESCALA	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:40
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ESC:
					ACOT.: METROS

DGOT-20-EST-III-0091-00292-P-00

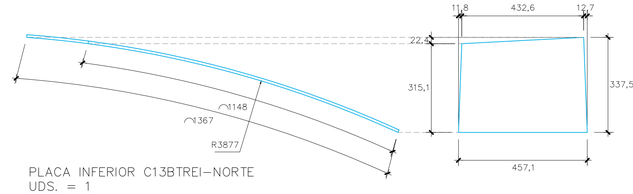




PLACAS LATERALES C13BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

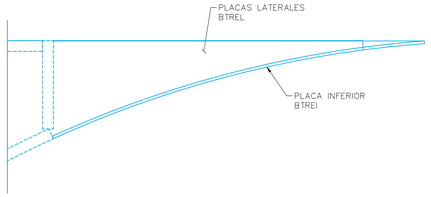


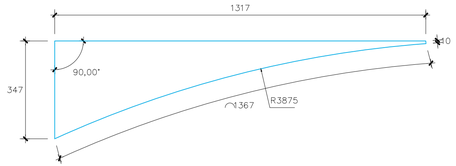
PLACAS LATERALES C13BTREL–NORTE–FRONTAL
UDS. = 1
ESPESOR = ⅜"



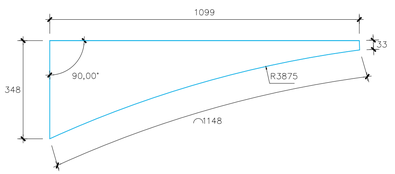
PLACA INFERIOR C13BTREI–NORTE
UDS. = 1
ESPESOR = ⅜"

COLUMNA 13 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10

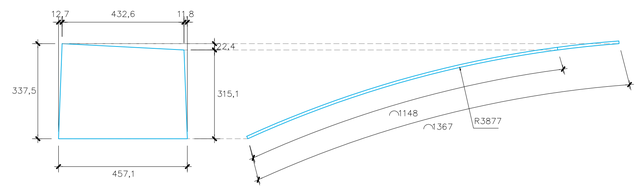




PLACAS LATERALES C13BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = ⅜"

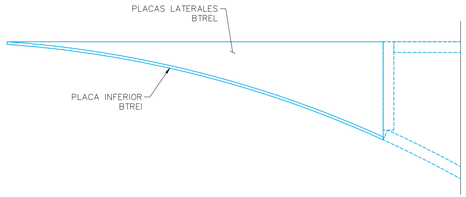


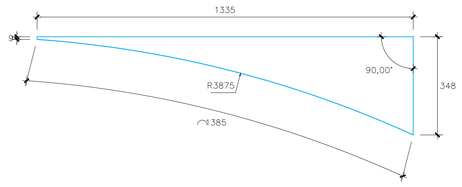
PLACAS LATERALES C13BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = ⅜"



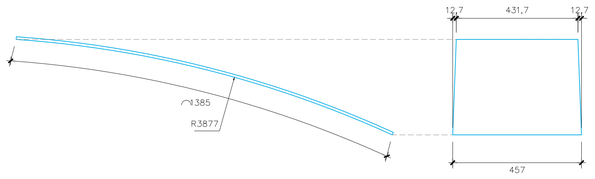
PLACA INFERIOR C13BTREI–SUR
UDS. = 1
ESPESOR = ⅜"

COLUMNA 13 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10



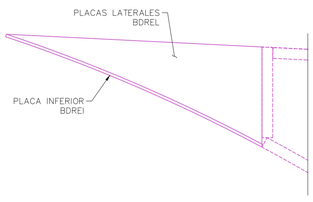


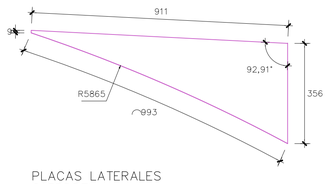
PLACAS LATERALES C13BTREL–C
UDS. = 4
ESPESOR = ⅜"



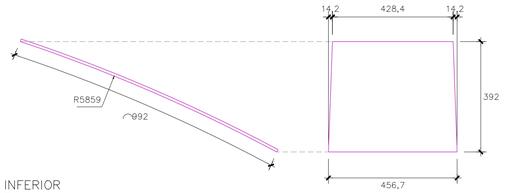
PLACA INFERIOR
C13BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 13
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



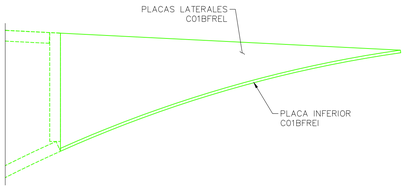


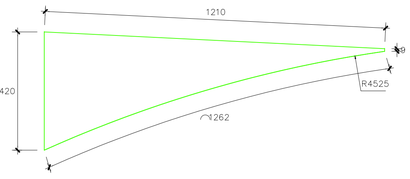
PLACAS LATERALES
C13BDREL
UDS. = 4
ESPESOR = ⅜"



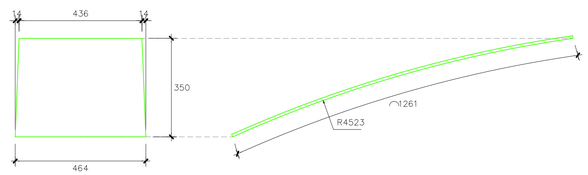
PLACA INFERIOR
C13BDREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 13
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10





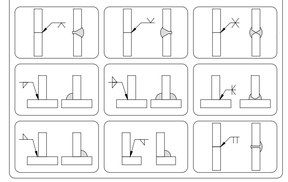
PLACAS LATERALES
C13BFREL
UDS. = 4
ESPESOR = ⅜"



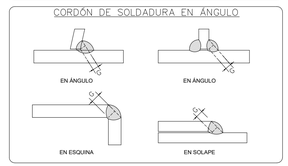
PLACA INFERIOR
C13BFREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 13
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

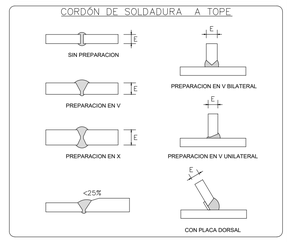
SIMBOLOGÍA Y RESULTADO

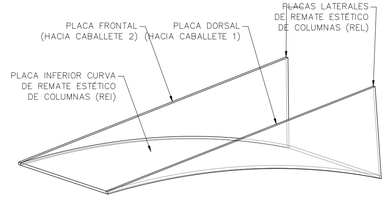


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR UNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO

APROBÓ: M. I. DANIEL PÉREZ BELLO
REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA
PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA
DIBUJÓ: M.B.
OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 13. DESPIECE

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

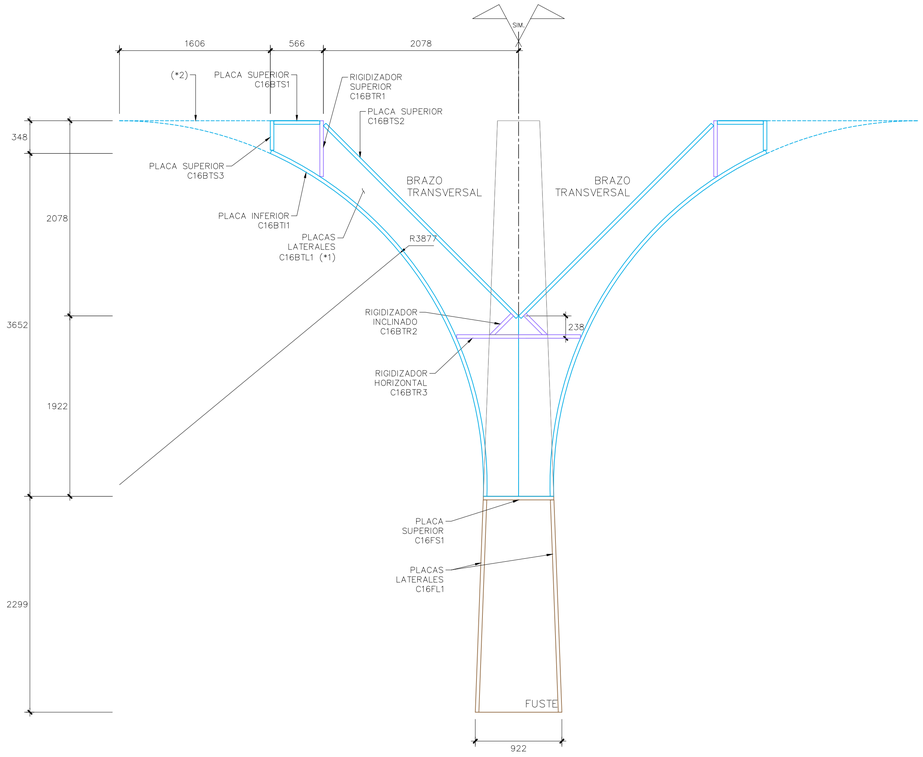
PLANO No: DGOT-20-EST-III-0068-00269-P-00

ESCALA GRÁFICA: 0 0.3 0.6 1

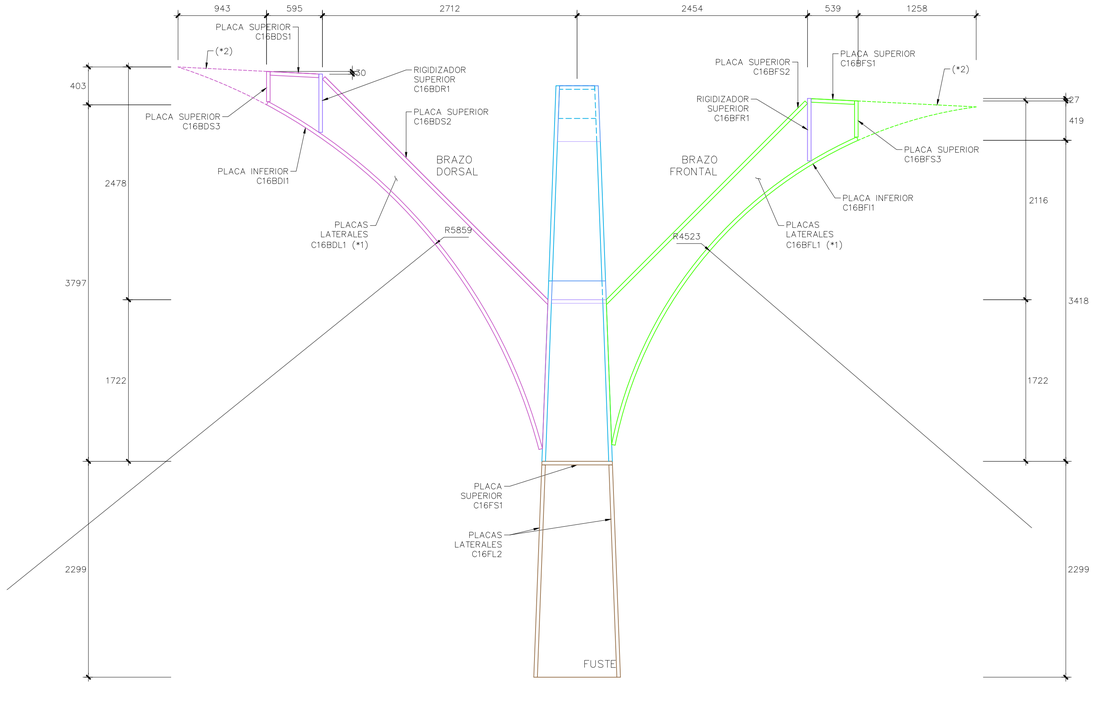
EJECUTÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:10
FECHA: JULIO 2021
ESC:
ACOT: METROS

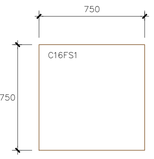
DGOT-20-EST-III-0068-00269-P-00



COLUMNA 16. SECCIÓN TRANSVERSAL
ESCALA 1:30



COLUMNA 16. SECCIÓN LONGITUDINAL (PDTE. DE CAJÓN= 5%)
ESCALA 1:30



PLACA SUPERIOR
C16FS1
UDS. = 2
ESPESOR = 1 ½"



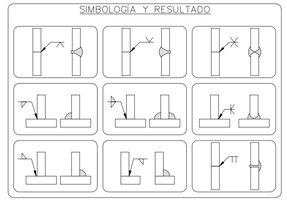
PLACAS
LATERALES C16FL1
UDS. = 4
ESPESOR = 1 ½"



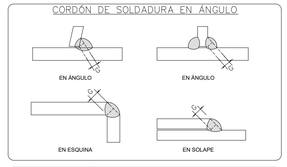
PLACAS
LATERALES C16FL2
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 16
DESPIECE DE FUSTE
ESCALA 1:20

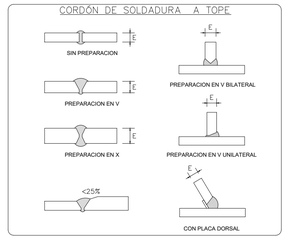
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS COLUMNA 16

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SANCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CORO-14252

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CORE-16992

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJO:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 16. VISTAS

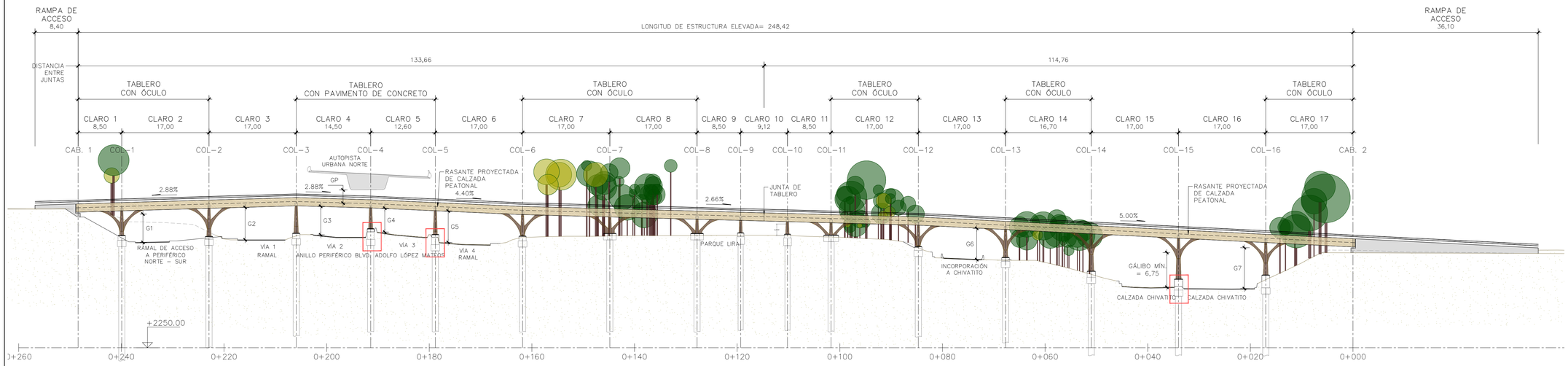
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0056-00257-P-00

ESCALA GRÁFICA: 0 0.5 0.9 1.5 3

FECHA:	DEPTO.	NOMBRE	FIRMA	MOD. 1:30
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ARQ. RAMÓN CAPISTRÁN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		DIBUJO
				ACOT. METROS

DGOT-20-EST-III-0056-00257-P-00



ALZADO LONGITUDINAL
ESCALA 1:400

GÁLIBOS	VIAL	PK PASARELA	EN EJE DE	MÍNIMO
G1	RAMAL ACCESO PERIFÉRICO	0+237.285	1.51	1.51
G2	VÍA 1 PERIFÉRICO	0+217.425	6.31	6.07
G3	VÍA 2 PERIFÉRICO NORTE - SUR	0+202.630	5.56	5.53
GP	GÁLIBO PEATONAL	0+194.937	2.58	2.52
G4	VÍA 3 PERIFÉRICO SUR - NORTE	0+190.170	4.65	4.38
G5	VÍA 4 PERIFÉRICO	0+178.062	6.12	5.94
G6	RAMAL INCORP. CHIVATITO	0+072.383	6.09	5.66 (*)
G7	CALZ. CHIVATITO SUR - NORTE	0+019.151	7.97	6.70

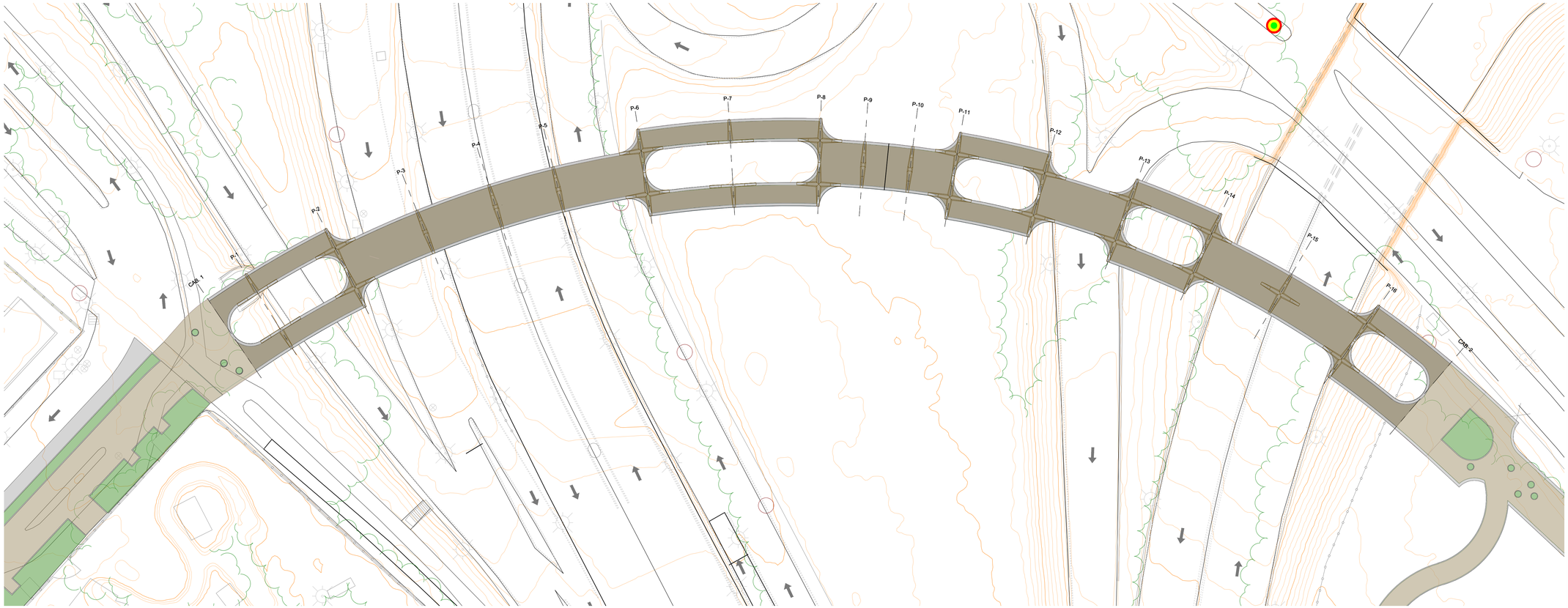
(*) NOTA

EN EL PLANO "DEFINICIÓN GENERAL. PLANTA DE GÁLIBOS" SE PROPONE UNA MODIFICACIÓN DEL RAMAL DE INCORPORACIÓN A CHIVATITO PARA QUE SE CUMPLA CON UN GÁLIBO VERTICAL DE 5.50 METROS BAJO LA CALZADA PEATONAL SIN NECESIDAD DE REALIZAR UNA RECTIFICACIÓN ALTIMÉTRICA DEL VIAL. LOS VALORES DE GÁLIBOS INDICADOS EN LA TABLA ADJUNTA SE OBTIENEN CONSIDERANDO ESTA MODIFCACIÓN.

PREVIA A LA REALIZACIÓN DE LOS TRABAJOS DEBERÁ REALIZARSE UN LEVANTAMIENTO ALTIMÉTRICO PRECISO DE LA ZONA AFECTADA. DEBERÁN COTEJARSE LOS VALORES OBTENIDOS CON EL REPLANTEO DE LA ESTRUCTURA POR SI FUESE NECESARIO PLANTEAR MODIFICACIONES.

PROTECCIÓN DE COLUMNAS

DEBERÁN REALIZARSE LAS ACTUACIONES NECESARIAS PARA PROTEGER DEBIDAMENTE LAS COLUMNAS FRENTE A LA COLISIÓN VEHICULAR. ESTAS ACTUACIONES SON OBJETO DE DEFINICIÓN INDEPENDIENTE.



PLANTA
ESCALA 1:400

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

NOTAS COLISIÓN DE VEHÍCULOS

1. EL DISEÑO DE LA ESTRUCTURA DE LA CALZADA PEATONAL SE REALIZA ASUMIENDO QUE SE RECTIFICARÁN LOS VIALES QUE LO REQUIERAN PARA CUMPLIR GÁLIBO VERTICAL DE 5.50 METROS; POR TANTO NO SE CONSIDERA COLISIÓN VEHICULAR CONTRA EL TABLERO EN EL DISEÑO ESTRUCTURAL. LA RECTIFICACIÓN DE LOS VIALES ES OBJETO DE DEFINICIÓN INDEPENDIENTE.
2. DEL MISMO MODO, TAMPOCO SE CONSIDERA COLISIÓN VEHICULAR EN EL DISEÑO DE LAS COLUMNAS, AL CONSIDERARSE QUE QUEDARÁN DEBIDAMENTE PROTEGIDAS. LAS RECTIFICACIONES NECESARIAS PARA PROTEGER LAS COLUMNAS SON OBJETO DE DEFINICIÓN INDEPENDIENTE.

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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DIRECTOR RESPONSABLE DE OBRA
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CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
DEFINICIÓN GENERAL
PLANTA Y DESARROLLO LONGITUDINAL

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0006-00217-P-00

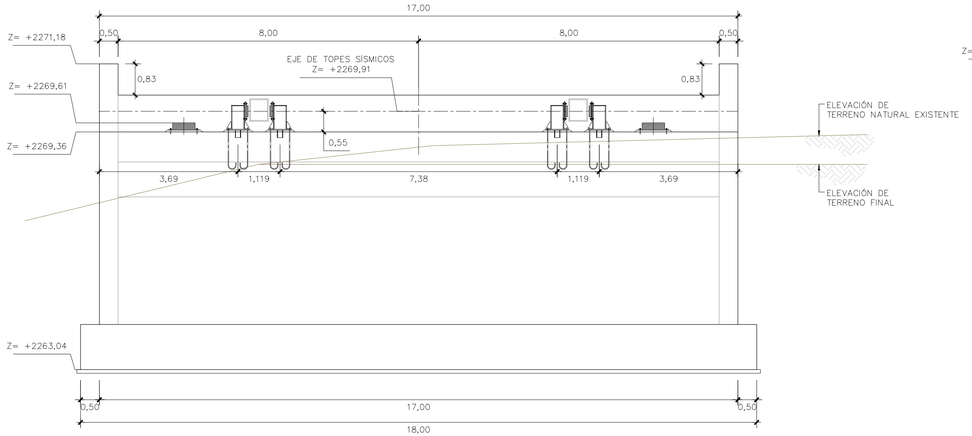
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FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

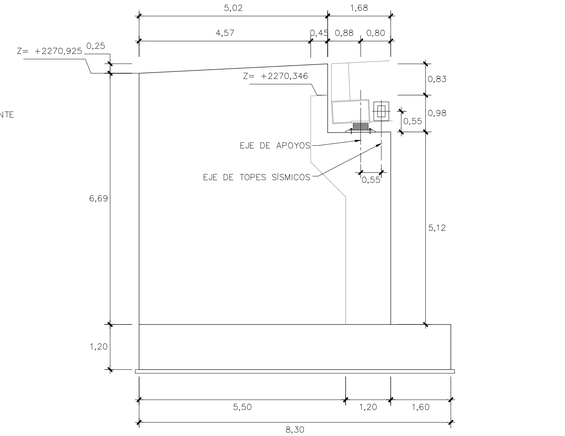
DETALLE

MOD: 1:400
FECHA: JULIO 2021
ESC:
ACOT: METROS

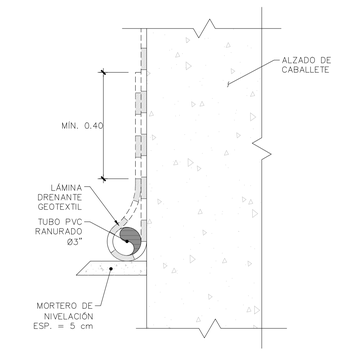
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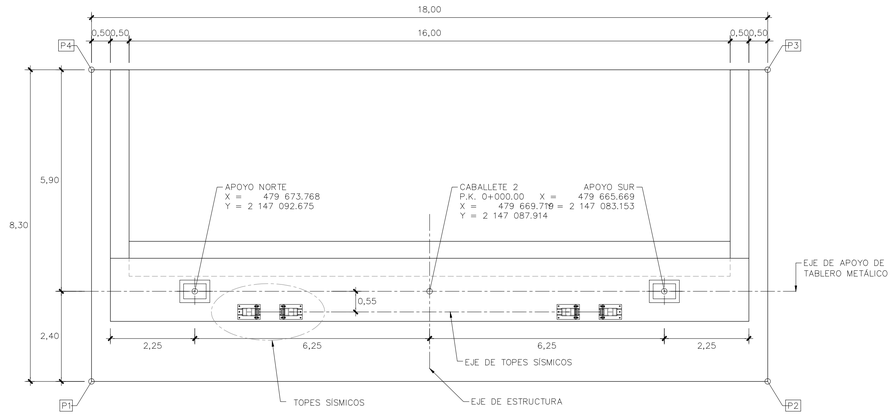


ALZADO LATERAL

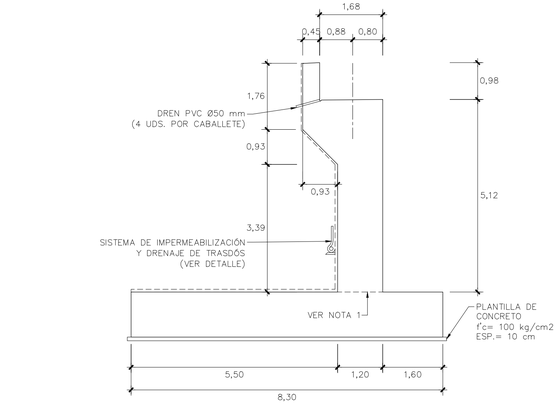


DETALLE DE DRENAJE DE TRASDÓS DE CABALLETES

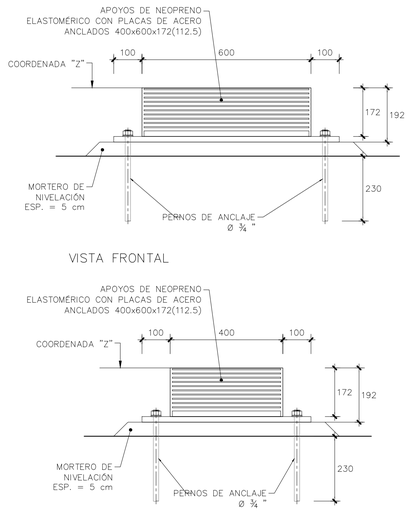
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PLANTA



SECCIÓN TIPO



VISTA FRONTAL

VISTA LATERAL

APOYOS DE TABLERO

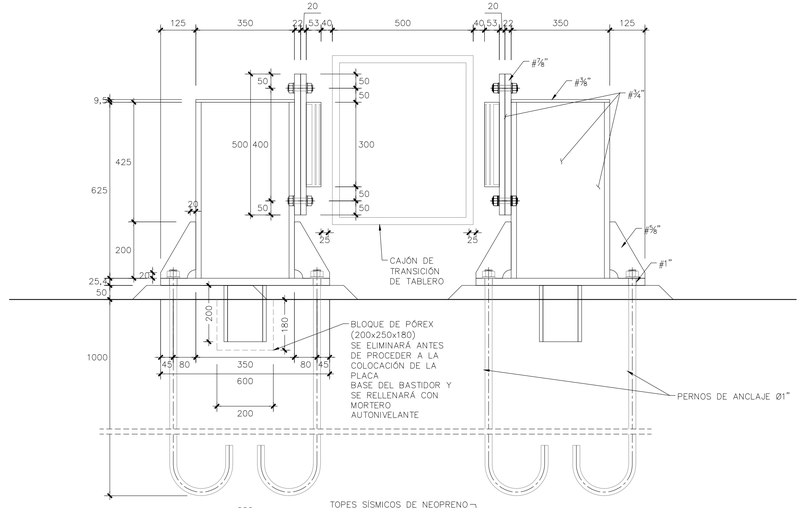
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PERNOS DE ANCLAJE DE APOYOS

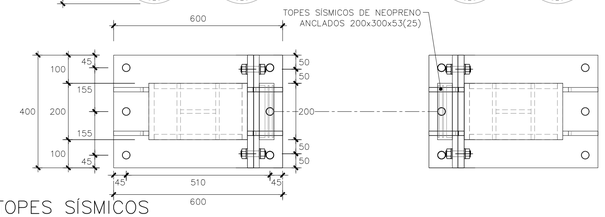
MATERIAL PERNOS:
ACERO ASTM F1554 GRADE 36

CABALLETE 2

ESCALA 1:75



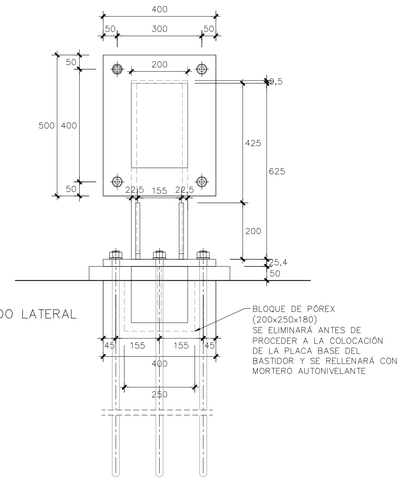
ALZADO



PLANTA

BASTIDORES PARA TOPES SÍSMICOS

ESCALA 1:10 (COTAS EN mm)



ALZADO LATERAL

CAB.2 – REPLANTEO CIMENTACIÓN

PUNTO	X	Y
P1	479 673.722	2 147 096.324
P2	479 662.060	2 147 082.613
P3	479 668.382	2 147 077.236
P4	479 680.044	2 147 090.947

NOTAS CABALLETES

1. JUNTA DE CONSTRUCCIÓN ENTRE CIMENTACIÓN Y ALZADO DE CABALLETE CON SUPERFICIE INTENCIONALMETNE RUGOSA.
2. LA COTA DEL TUBO PARA DRENAJE DE TRASDÓS DE CABALLETES SERÁ LO MÁS PRÓXIMA POSIBLE A LA CARA SUPERIOR DE LA ZAPATA, SIEMPRE QUE SE GARANTICE QUE EL AGUA DRENADA SE PUEDA EVACUAR DESDE EL TUBO PERFORADO HACIA UNA RED DE SANEAMIENTO EXISTENTE O BIEN HACIA EL TALUD FINAL, A TRAVÉS DEL RELLENO DE TIERRAS EN EL FRONTAL DEL CABALLETE, SEGÚN LOS CONDICIONANTES REALES DEL SITIO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
Δ	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FIEDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FIEDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUDO RAMÓN MONTERO OROZCO
CSE-1495

APROBO: M. I. DANIEL PÉREZ BELLO

REVISO: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO: M.I. EDUARDO DÁVILA ORTEGA

DIBUJO: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CABALLETE 2
GEOMETRÍA Y REPLANTEO

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

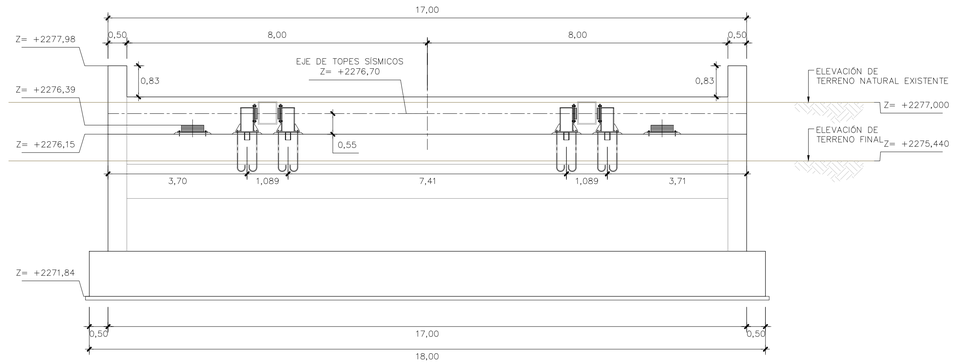
PLANO No.: **DGOT-20-EST-III-0008-00209-P-00**

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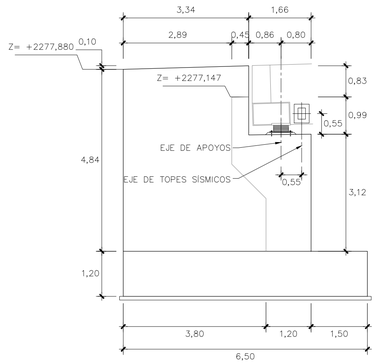
DEPTO.	NOMBRE	FIRMA
PROYECTO	M.I. INCENCIO MALDONADO TORRES	
ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:75
FECHA: JULIO 2021
ESC:
ACOT.: METROS

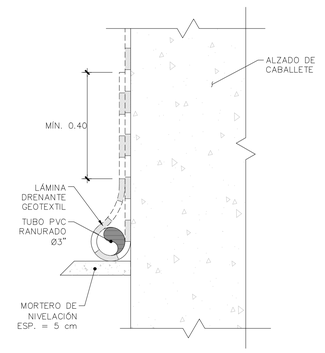
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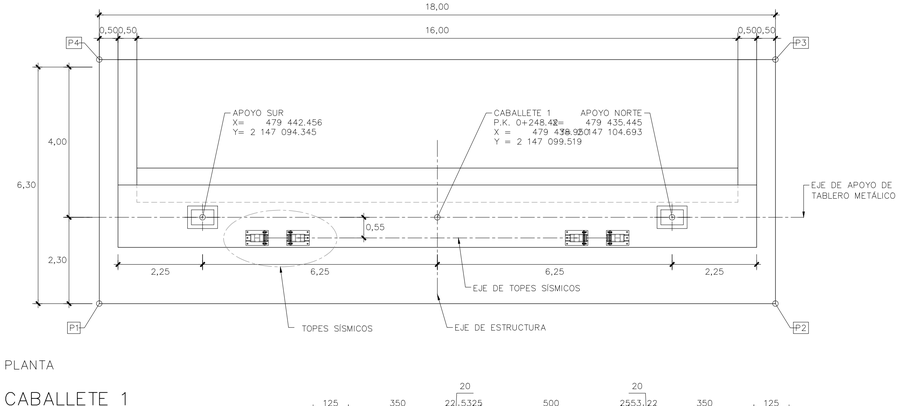
ALZADO FRONTAL



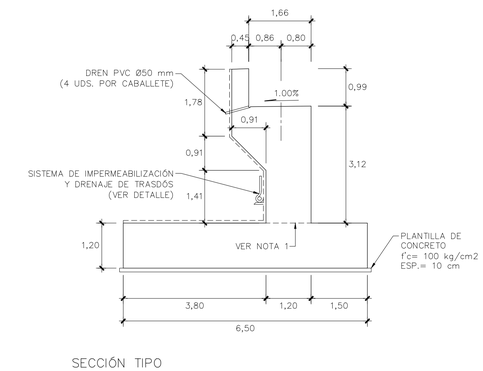
ALZADO LATERAL



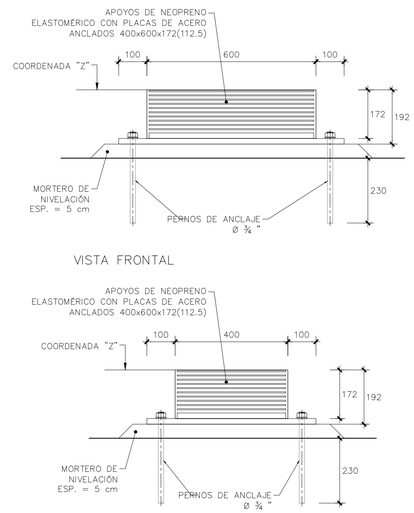
DETALLE DE DRENAJE
DE TRASDÓS DE CABALLETES
ESCALA 1:10



PLANTA



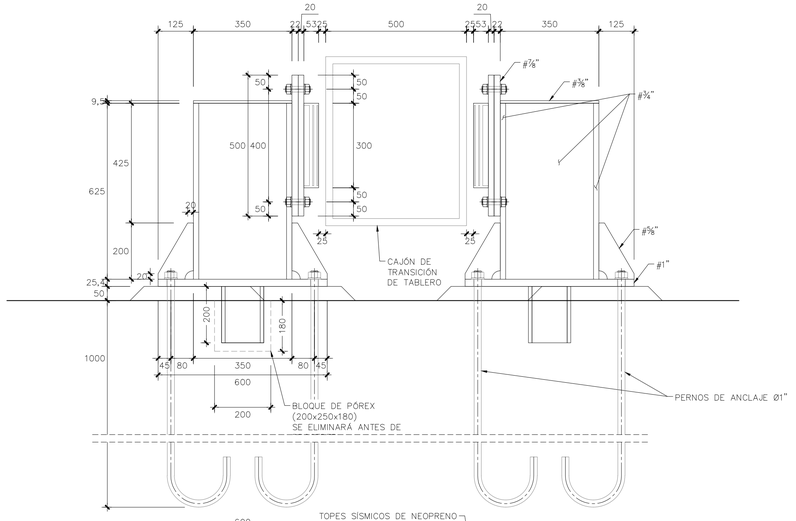
SECCIÓN TIPO



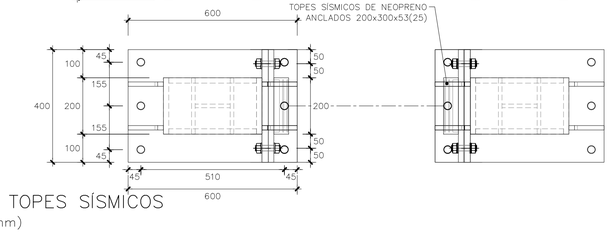
VISTA FRONTAL

VISTA LATERAL

CABALLETE 1
ESCALA 1:75

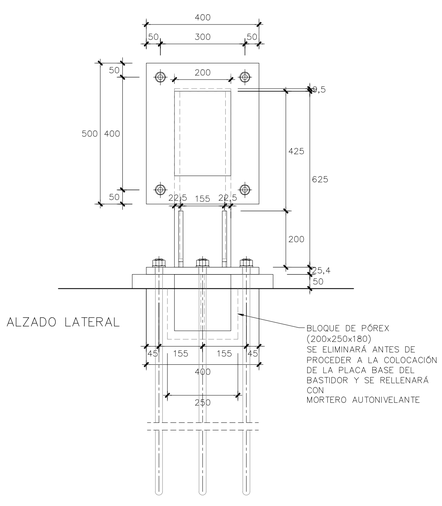


ALZADO



PLANTA

BASTIDORES PARA TOPES SÍSMICOS
ESCALA 1:10 (COTAS EN mm)



ALZADO LATERAL

APOYOS DE TABLERO
ESCALA 1:10 (COTAS EN mm)

PERNOS DE ANCLAJE DE APOYOS

MATERIAL PERNOS:
ACERO ASTM F1554 GRADE 36

CAB.1 – REPLANTEO
CIMENTACIÓN

PUNTO	X	Y
P1		
P2		
P3		
P4		

479 445.903 2 147 093.358
479 435.806 2 147 108.260
479 438.426 2 147 114.521

NOTAS CABALLETES

1. JUNTA DE CONSTRUCCIÓN ENTRE CIMENTACIÓN Y ALZADO DE CABALLETE CON SUPERFICIE INTENCIONALMETNE RUGOSA.
2. LA COTA DEL TUBO PARA DRENAJE DE TRASDÓS DE CABALLETES SERÁ LO MÁS PRÓXIMA POSIBLE A LA CARA SUPERIOR DE LA ZAPATA, SIEMPRE QUE SE GARANTICE QUE EL AGUA DRENADA SE PUEDA EVACUAR DESDE EL TUBO PERFORADO HACIA UNA RED DE SANEAMIENTO EXISTENTE O BIEN HACIA EL TALUD FINAL, A TRAVÉS DEL RELLENO DE TIERRAS EN EL FRONTAL DEL CABALLETE, SEGÚN LOS CONDICIONANTES REALES DEL SITIO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

PIEDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR UNICO
PIEDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1666

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE 12855

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CABALLETE 1
GEOMETRÍA Y REPLANTEO

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

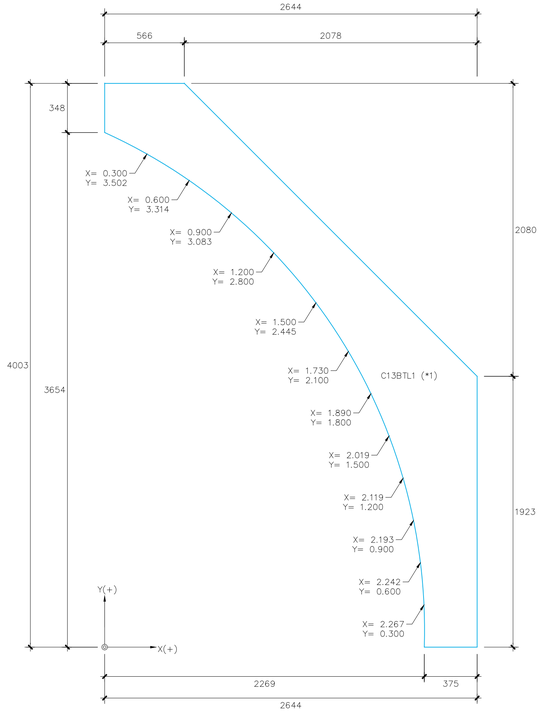
PLANO No:
DGOT-20-EST-III-0007-00208-P-00

ESCALA GRÁFICA: 1:25 2:25 3:25 4:25

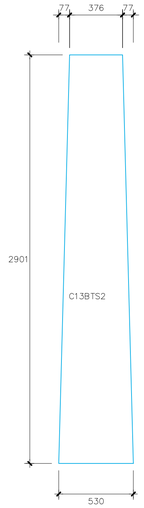
EJECUTÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INCIENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:75
FECHA: JULIO 2021
ESC:
ACOT: METROS

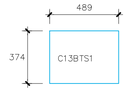
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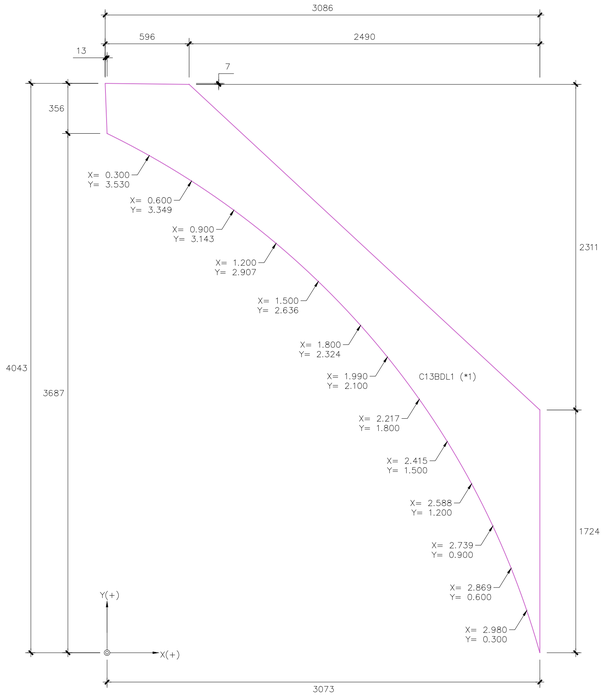
PLACAS
LATERALES
C13BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



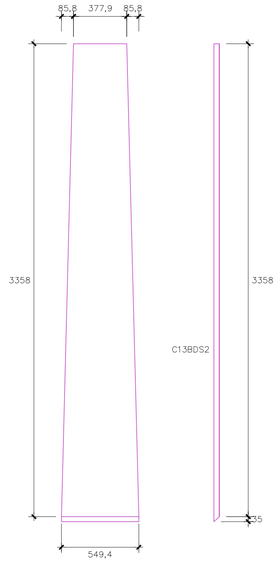
PLACAS SUPERIORES
C13BTS2
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C13BTS1
UDS. = 4
ESPESOR = 1 ½"

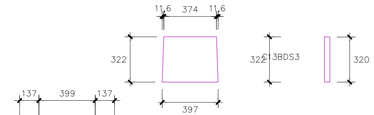


PLACAS
LATERALES
C13BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



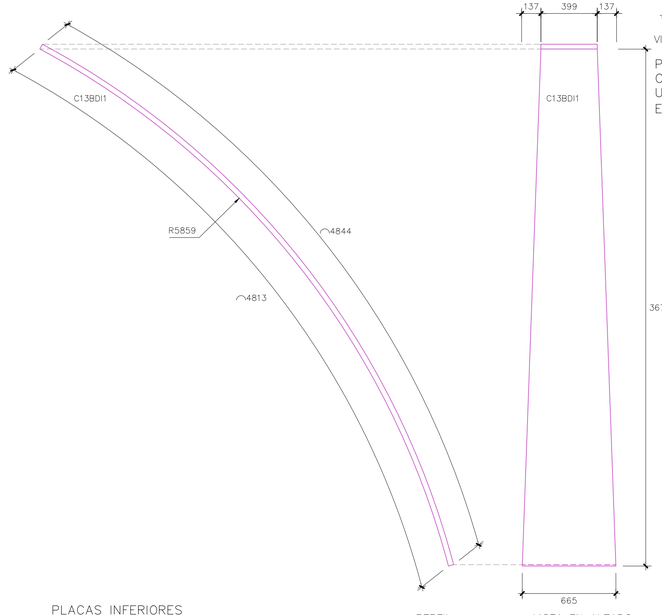
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C13BDS2
UDS. = 2
ESPESOR = 1 ½"



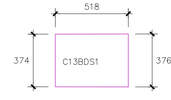
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C13BDS3
UDS. = 2
ESPESOR = 1 ½"

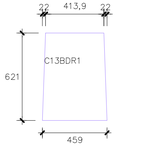


PERFIL VISTA EN ALZADO

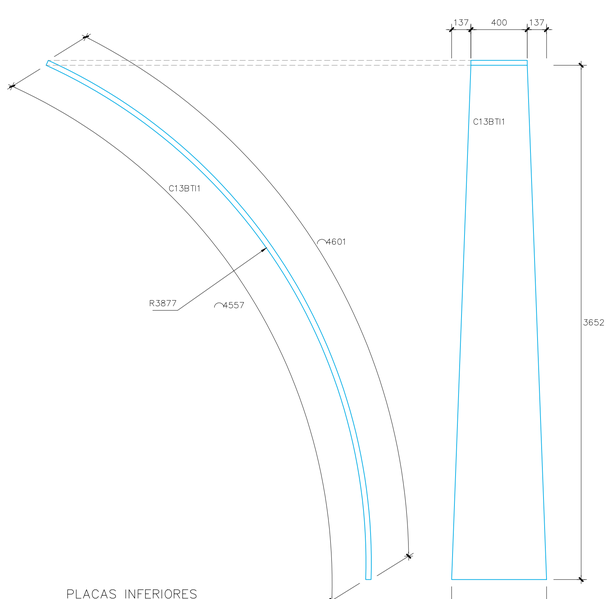
PLACAS INFERIORES
C13BDI1
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C13BDS1
UDS. = 2
ESPESOR = 1 ½"

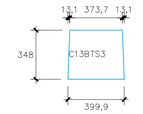


PLACAS
RIGIDIZADORAS
C13BDR1
UDS. = 2
ESPESOR = 1 ½"

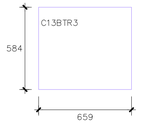


PERFIL VISTA EN ALZADO

PLACAS INFERIORES
C13BTI1
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C13BTS3
UDS. = 4
ESPESOR = 1 ½"

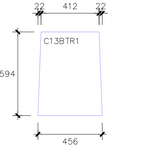


RIGIDIZADORES
C13BTR3
UDS. = 4
ESPESOR = 1 ½"



PERFIL ALZADO

RIGIDIZADORES
C13BTR2
UDS. = 4
ESPESOR = 1 ½"

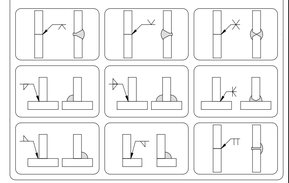


RIGIDIZADORES
C13BTR1
UDS. = 4
ESPESOR = 1 ½"

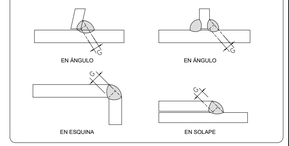
COLUMNA 13
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

COLUMNA 13
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

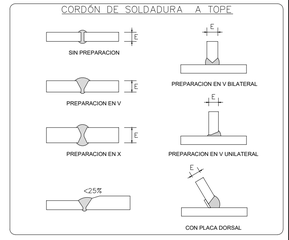
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 13
UNIDADES = 2 COLUMNAS

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
PREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1998

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-1998

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 13. DESPIECE (I)

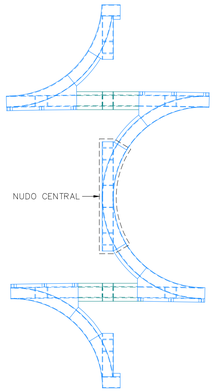
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

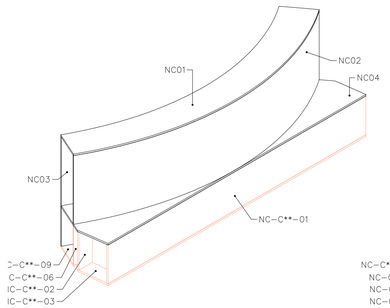
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DGOT-20-EST-III-0048-00249-P-00

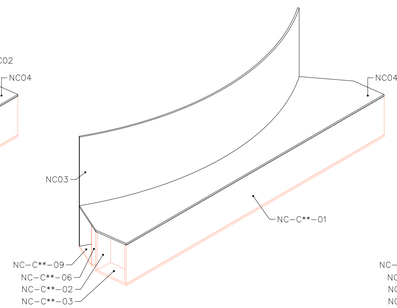
ESCALA GRÁFICA: 0.2 0.6 1

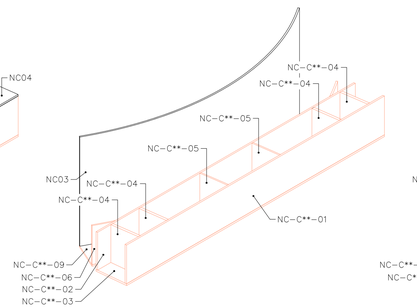
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

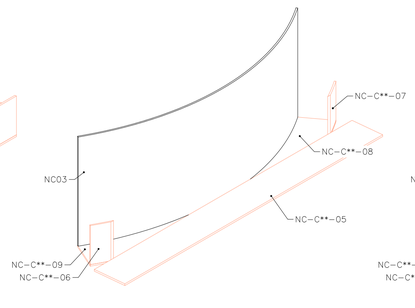
DGOT-20-EST-III-0048-00249-P-00

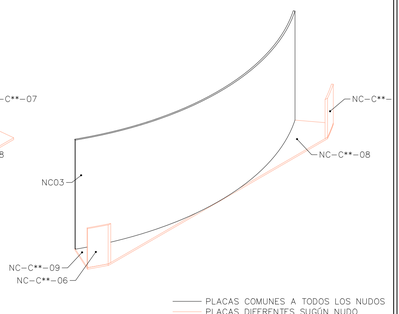






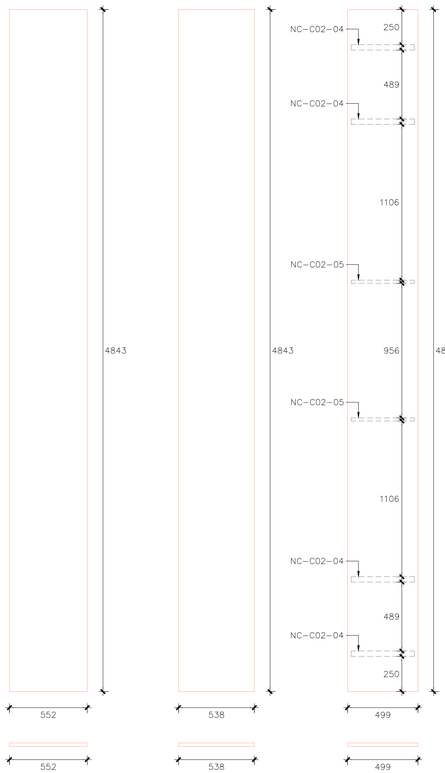






PLACAS COMUNES A TODOS LOS NUDOS
PLACAS DIFERENTES SUGÚN NUDO

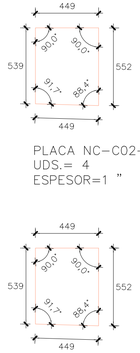
NUDOS INICIO DE ÓCULO. PLANTADO CENTRAL. PERSPECTIVAS
ESCALA 1:125 SIN ESCALA



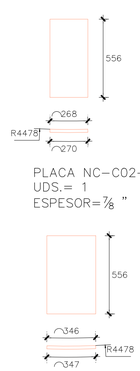
PLACA NC-C02-01
UDS.= 1
ESPESOR=1 "

PLACA NC-C02-02
UDS.= 1
ESPESOR=1 "

PLACA NC-C02-03
UDS.= 1
ESPESOR=1 "



PLACA NC-C02-05
UDS.= 2
ESPESOR=⅞ "



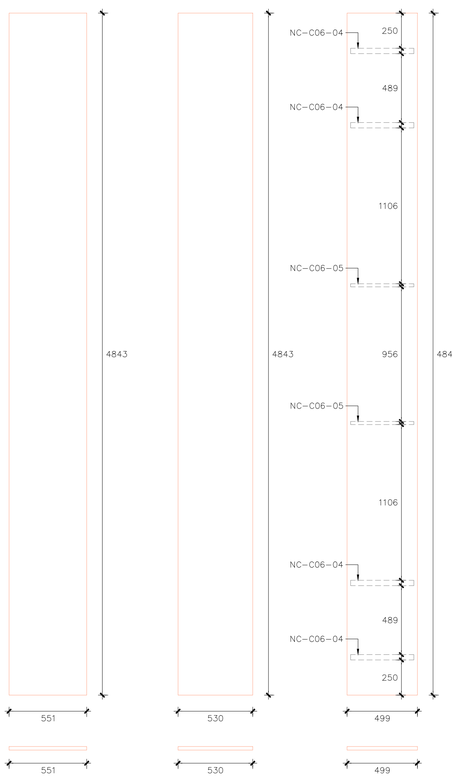
PLACA NC-C02-06
UDS.= 1
ESPESOR=⅞ "

PLACA NC-C02-07
UDS.= 1
ESPESOR=⅞ "



PLACA NC-C02-08
UDS.= 1
ESPESOR=⅞ "

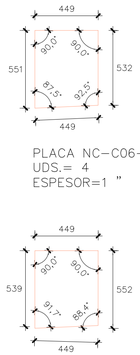
PLACA NC-C02-09
UDS.= 1
ESPESOR=⅞ "



PLACA NC-C06-01
UDS.= 1
ESPESOR=1 "

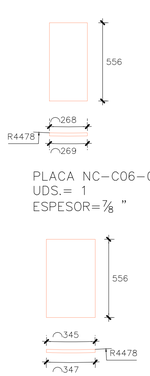
PLACA NC-C06-02
UDS.= 1
ESPESOR=1 "

PLACA NC-C06-03
UDS.= 1
ESPESOR=1 "



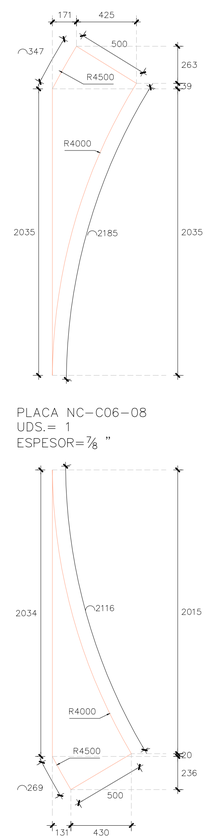
PLACA NC-C06-04
UDS.= 4
ESPESOR=1 "

PLACA NC-C06-05
UDS.= 2
ESPESOR=⅞ "



PLACA NC-C06-06
UDS.= 1
ESPESOR=⅞ "

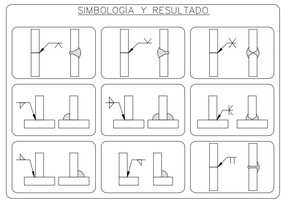
PLACA NC-C06-07
UDS.= 1
ESPESOR=⅞ "



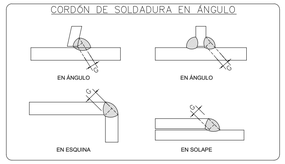
PLACA NC-C06-08
UDS.= 1
ESPESOR=⅞ "

PLACA NC-C06-09
UDS.= 1
ESPESOR=⅞ "

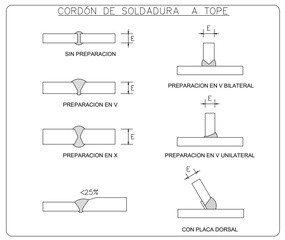
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



NUDO CENTRAL EN COLUMNA C-02

NUDO CENTRAL. DESPICE DE PLACAS VARIABLES
ESCALA 1:20

NUDO CENTRAL EN COLUMNA C-06

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN-AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.

ADMINISTRADOR UNICO FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO

APROBO: M. I. DANIEL PÉREZ BELLO
REVISO: M.V.T. GERMÁN GARCÍA DEHEZA
PROYECTO: M.I. EDUARDO DÁVILA ORTEGA
DIBUJO: M.B.
OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (IX)

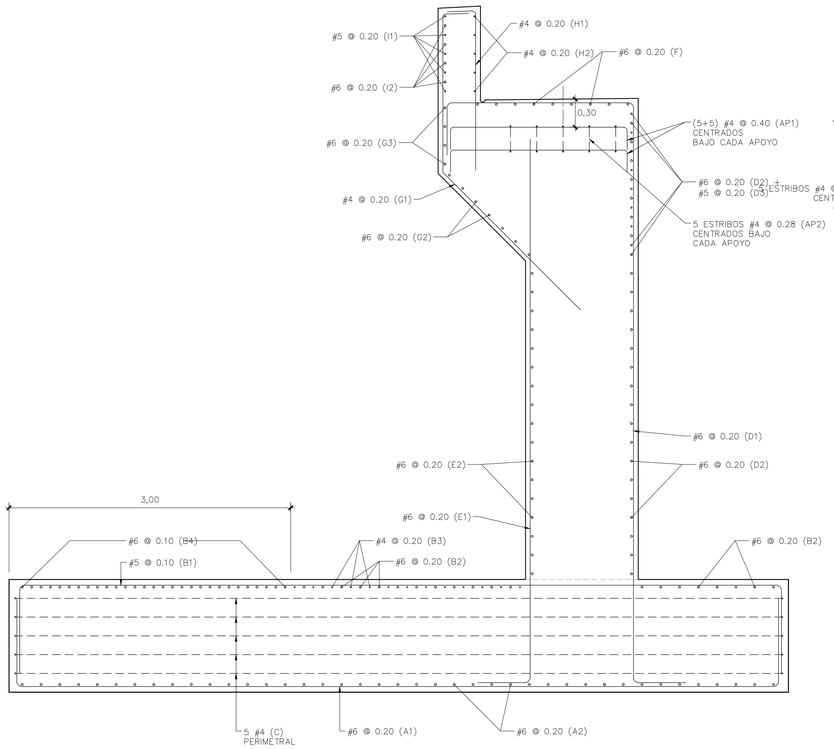
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0103-00304-P-00**

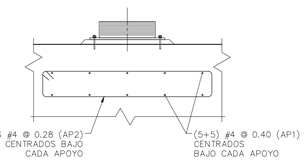
ESCALA GRÁFICA: 0 2 5 8 1 4

	FECHA:	DEPTO:	NOMBRE:	FIRMA:	MOD: 1:20
DISEÑO		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

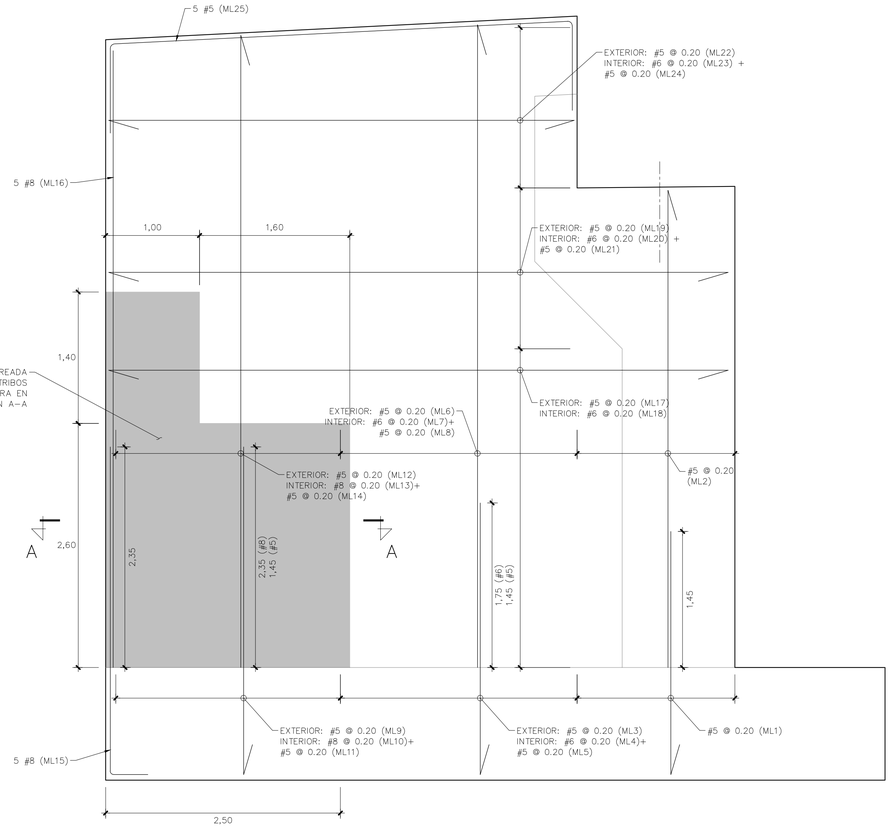
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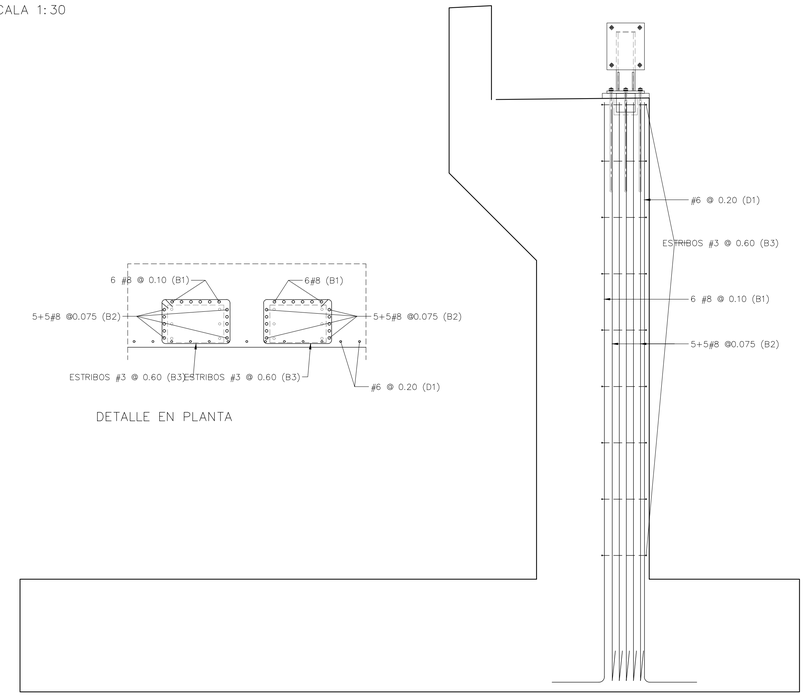
CABALLETE 2. REFUERZO
SECCIÓN TIPO
ESCALA 1:30



DETALLE DE REFUERZO BAJO APOYOS

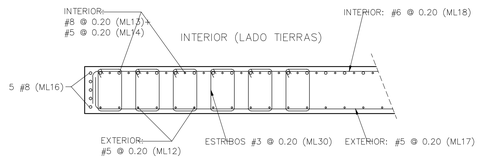


CABALLETE 2. REFUERZO
MURO LATERAL
ESCALA 1:30



DETALLE EN PLANTA

ARMADURA BAJO BASTIDORES PARA TOPES SÍSMICOS
SECCIÓN TIPO
ESCALA 1:30



CABALLETE 2. REFUERZO
MURO LATERAL. SECCIÓN A–A
ESCALA 1:30

CONCRETO

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES EN EL PLANO DE NOTAS GENERALES.

ACERO DE REFUERZO

- CONSULTAR LONGITUDES DE TRASLAPE, ANCLAJES Y OTROS DETALLES EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1450

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CISE-0085

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CABALLETES
CABALLETE 1. REFUERZO

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

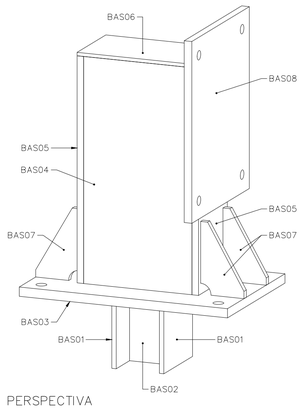
PLANO No: **DGOT-20-EST-III-0011-00212-P-00**

ESCALA GRÁFICA: 0.3 0.9 1.5

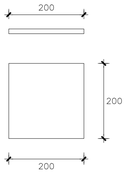
CONTROL	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:30
FECHA: JULIO 2021
ESC:
ACOT: METROS

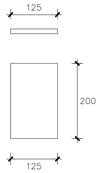
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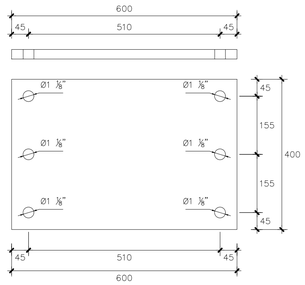
PERSPECTIVA



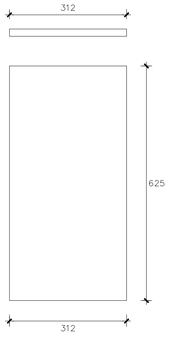
PLACA BAS01
TOT. UDS. POR BASTIDOR = 2
TOT. UDS. POR CABALLETE= 4
TOT. UDS.= 8
ESPESOR = ½"



PLACA BAS02
TOT. UDS. POR BASTIDOR = 1
TOT. UDS. POR CABALLETE= 2
TOT. UDS.= 4
ESPESOR = ½"



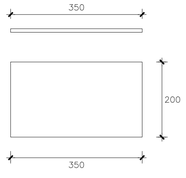
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TOT. UDS. POR BASTIDOR = 1
TOT. UDS. POR CABALLETE= 2
TOT. UDS.= 4
ESPESOR = 1"



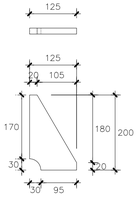
PLACA BAS04
TOT. UDS. POR BASTIDOR = 2
TOT. UDS. POR CABALLETE= 4
TOT. UDS.= 8
ESPESOR = ¾ "



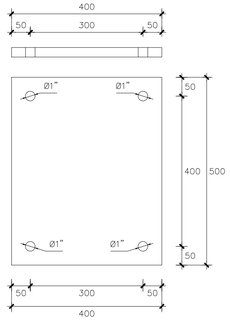
PLACA BAS05
TOT. UDS. POR BASTIDOR = 2
TOT. UDS. POR CABALLETE= 4
TOT. UDS.= 8
ESPESOR = ¾ "



PLACA BAS06
TOT. UDS. POR BASTIDOR = 1
TOT. UDS. POR CABALLETE= 2
TOT. UDS.= 4
ESPESOR = ⅜ "



PLACA BAS07
TOT. UDS. POR BASTIDOR = 4
TOT. UDS. POR CABALLETE= 8
TOT. UDS.= 16
ESPESOR = ⅝ "



PLACA BAS08
TOT. UDS. POR BASTIDOR = 1
TOT. UDS. POR CABALLETE= 2
TOT. UDS.= 4
ESPESOR = ⅞ "

BASTIDOR CABALLETE 1 Y 2
DESPIECE DE PLACAS
ESCALA 1:7.5

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA:
ING. ARQ. EDMUNDO REYES MACRO
CED.1420

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED.2640

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
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TÍTULO DEL PLANO:
CABALLETE 1 y 2
DESPIECE DE BASTIDOR

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0009-00210-P-00

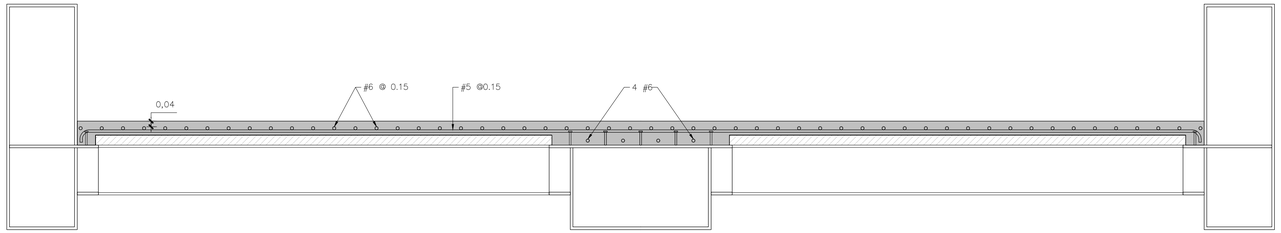
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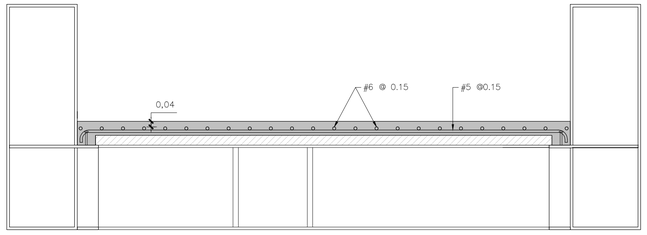
FECHA:	DEPTO:	NOMBRE:	FIRMA:
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

DISEÑO

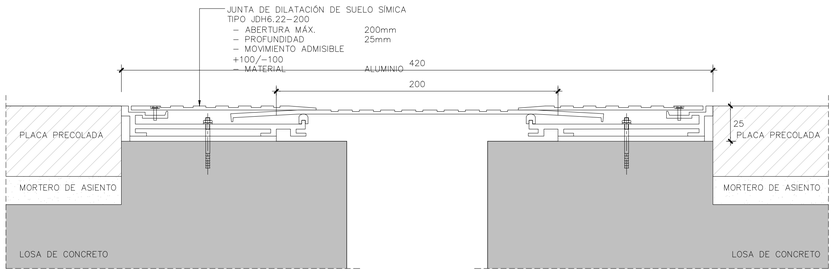
MOD: 1.7.5
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0009-00210-P-00





LOSA SUPERIOR
REFUERZO
ESCALA 1:20



JUNTA DE DILATACIÓN EN CABALLETE 1 Y 2 Y CLARO 10
JUNTA TIPO JDH 6.22-200
SIN ESCALA (COTAS EN mm)

IMPORTANTE

- LA PLACA INTERMEDIA SE INSTALARÁ CON UNA LONGITUD TOTAL INFERIOR A LA ANCHURA TOTAL DE LA JUNTA PARA PODER ACOMODAR LOS DESPLAZAMIENTOS TRANSVERSALES RELATIVOS PREVISTOS ENTRE TRAMOS CONTIGUOS DE TABLERO, ASÍ COMO ENTRE TABLERO Y CABALLETES. ESTA REDUCCIÓN DE LONGITUD SERÁ DE 40mm PARA LAS JUNTAS DE CABALLETES Y DE 80mm PARA LA JUNTA DE CENTRO DE CLARO.
- ANCHURA TOTAL DE LA JUNTA EN CABALLETES: 16.00 METROS (ANCHURA DE LA PLACA INTERMEDIA: 15.96 METROS)
- ANCHURA TOTAL DE LA JUNTA EN CENTRO DE CLARO: 8.00 METROS (ANCHURA DE LA PLACA INTERMEDIA: 7.92 METROS)

CONCRETO

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES EN EL PLANO DE NOTAS GENERALES.

ACERO DE REFUERZO

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CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

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3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
Δ	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRIDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-1495

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO
LOSA SUPERIOR
REFUERZO Y JUNTAS DE DILATACIÓN

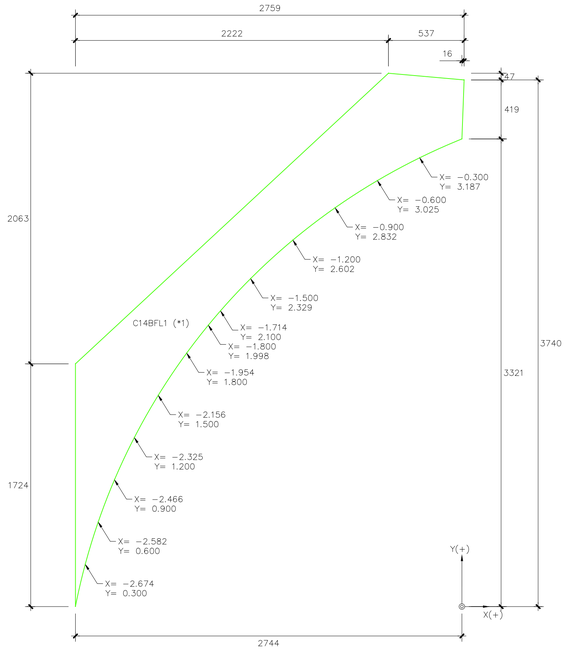
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0113-00314-P-00**

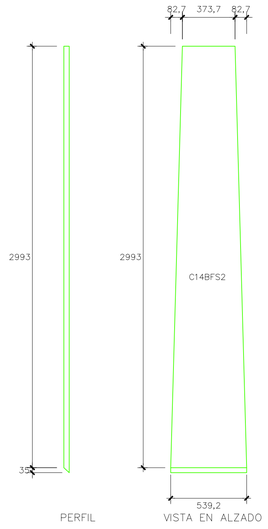
ESCALA GRÁFICA: 0.2 0.6 1

FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
	ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN		ESC:
	ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ACOT: METROS

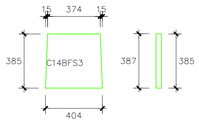
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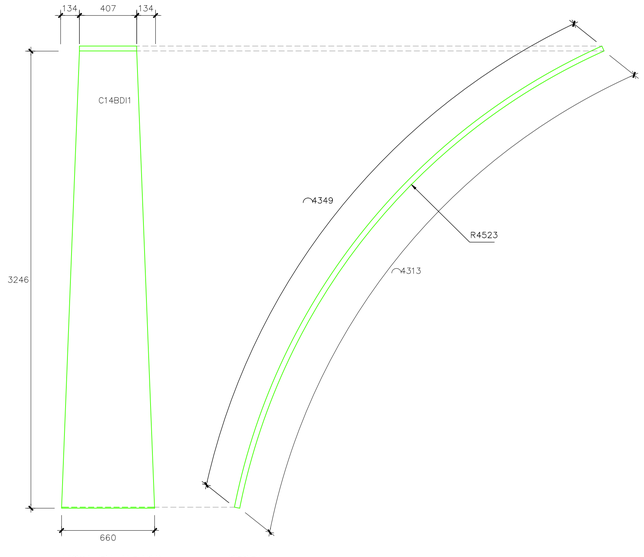
PLACAS
LATERALES
C14BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



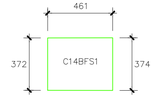
PLACAS SUPERIORES
C14BFS2
UDS. = 2
ESPESOR = 1 ½"



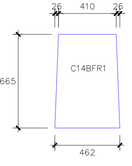
PLACAS SUPERIORES
C14BFS3
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C15BFI1
UDS. = 1
ESPESOR = 1 ½"



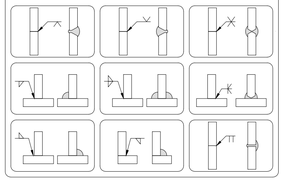
PLACAS SUPERIORES
C14BFS1
UDS. = 2
ESPESOR = 1 ½"



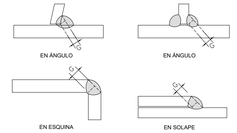
PLACAS
RIGIDIZADORAS
C14BFR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 14
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20

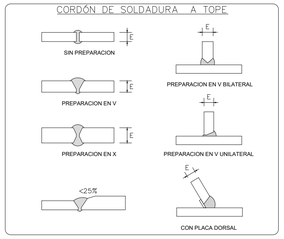
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 14

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
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SUBSECRETARÍA DE INFRAESTRUCTURA

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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED.1456

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED.1456

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 14. DESPIECE (II)

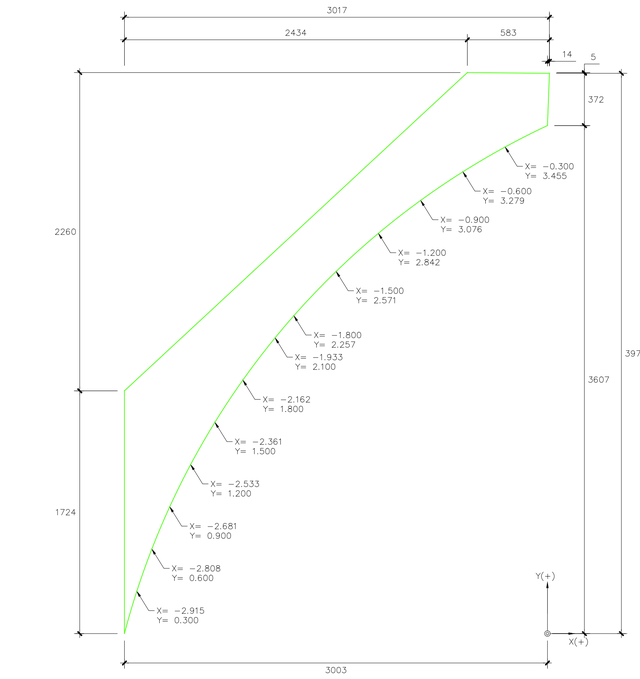
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0052-00253-P-00**

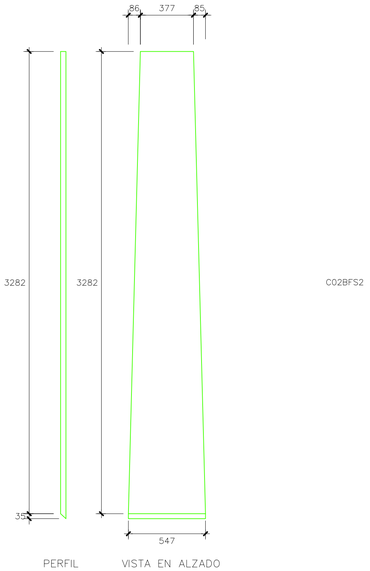
ESCALA GRÁFICA: 0.2 0.6 1

FECHA	DEPTO.	NOMBRE	FIRMA	
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:20
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT. METROS

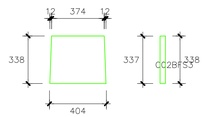
DGOT-20-EST-III-0052-00253-P-00



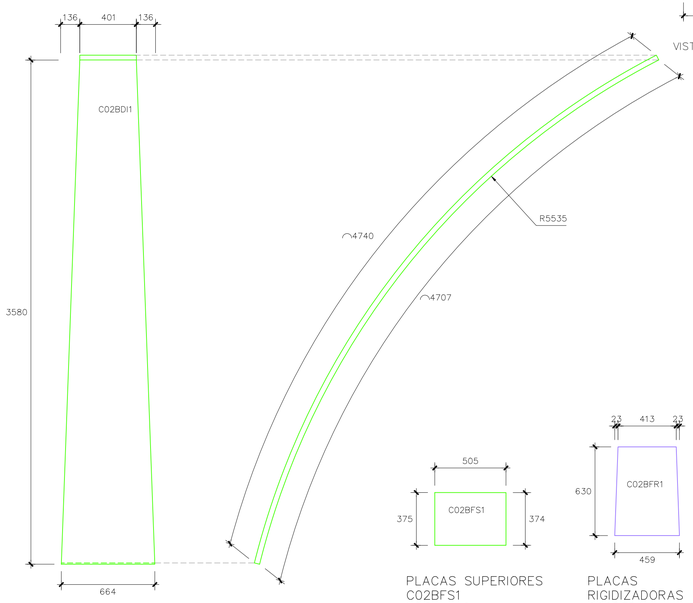
PLACAS
LATERALES
C02BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C02BFS2
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C02BFS3
UDS. = 2
ESPESOR = 1 ½"

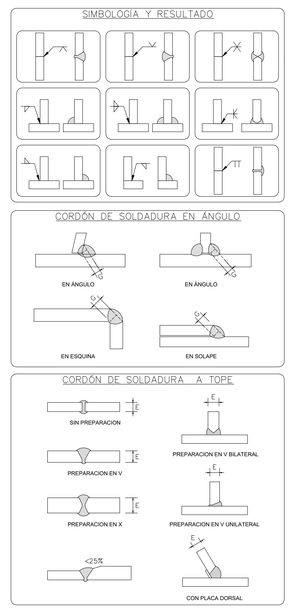


PLACAS INFERIORES
C02BFI1
UDS. = 2
ESPESOR = 1 ½"

PLACAS SUPERIORES
C02BFS1
UDS. = 2
ESPESOR = 1 ½"

PLACAS
RIGIDIZADORAS
C02BFR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 2
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 2

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO COE-0005

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 2. DESPIECE (II)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

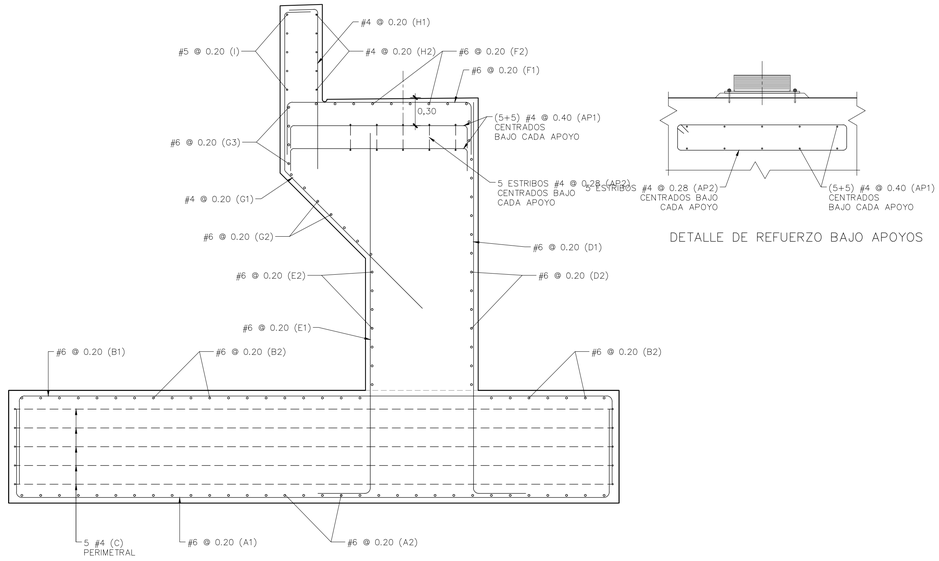
PLANO No.
DGOT-20-EST-III-0029-00230-P-00

ESCALA GRÁFICA: 0.0 2.5 5.0

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

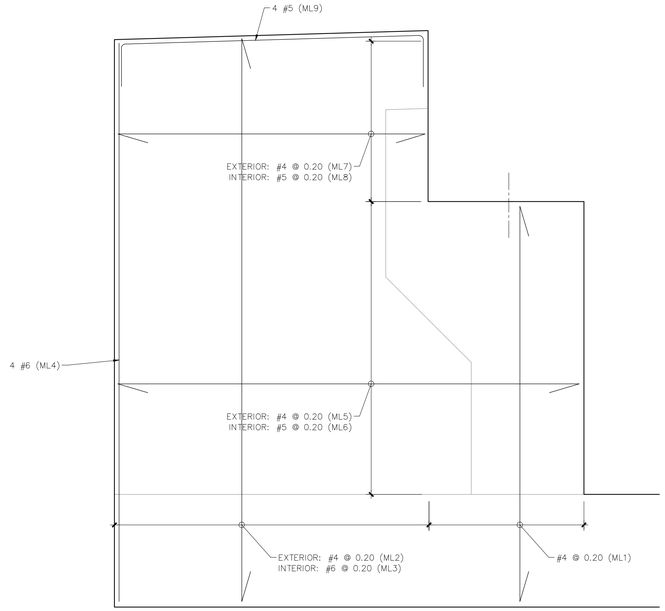
MOD. 1:20
FECHA: JULIO 2021
ESC.
ACOT. METROS

DGOT-20-EST-III-0029-00230-P-00

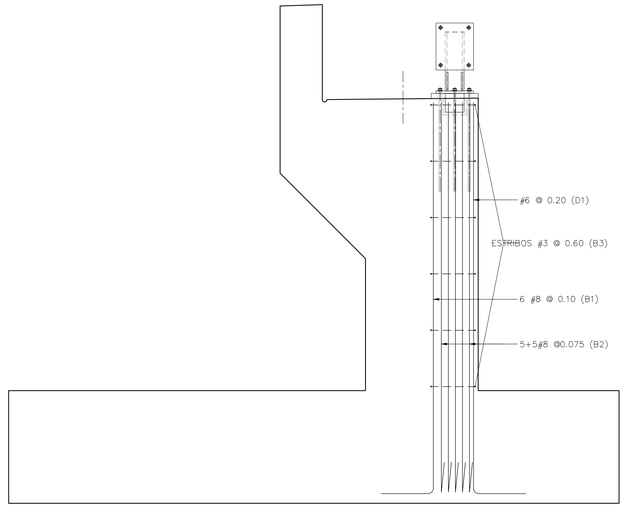


CABALLETE 1. REFUERZO
SECCIÓN TIPO
ESCALA 1:30

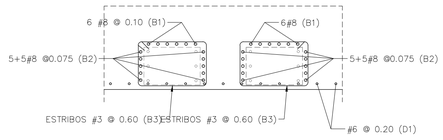
DETALLE DE REFUERZO BAJO APOYOS



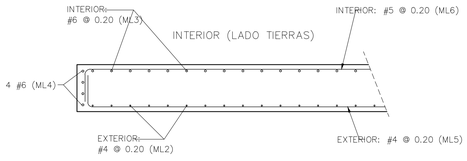
CABALLETE 1. REFUERZO
MURO LATERAL
ESCALA 1:30



ARMADURA BAJO BASTIDORES PARA TOPES SÍSMICOS
SECCIÓN TIPO
ESCALA 1:30



DETALLE EN PLANTA



CABALLETE 1. REFUERZO
MURO LATERAL. SECCIÓN A–A
ESCALA 1:30

CONCRETO

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES EN EL PLANO DE NOTAS GENERALES.

ACERO DE REFUERZO

- CONSULTAR LONGITUDES DE TRASLAPE, ANCLAJES Y OTROS DETALLES EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

GOBIERNO DE LA CIUDAD DE MÉXICO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO	DIRECTOR RESPONSABLE DE OBRA	CORRESPONSAL ESTRUCTURAL
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.	ING. ARQ. EDMUNDO REYES MADRID DRO 1488	ING. LUCIO RAMÓN MONTERO OROZCO DRE 1488
ING. DAVID S. QUINTERO CAMPOS		

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

CABALLETES
CABALLETE 1. REFUERZO

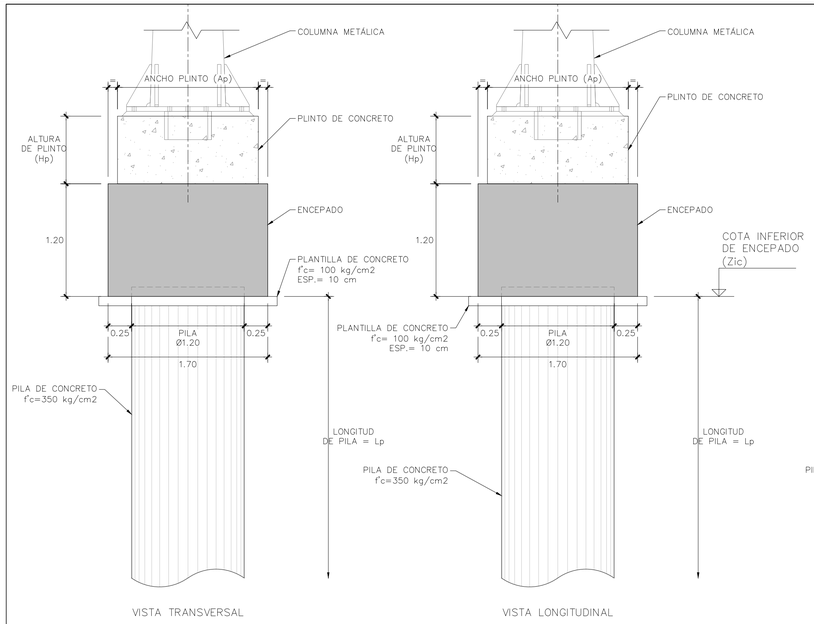
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0010-00211-P-00**

ESCALA GRÁFICA: 0.3 0.9 1.5

ESCALA	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:30
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

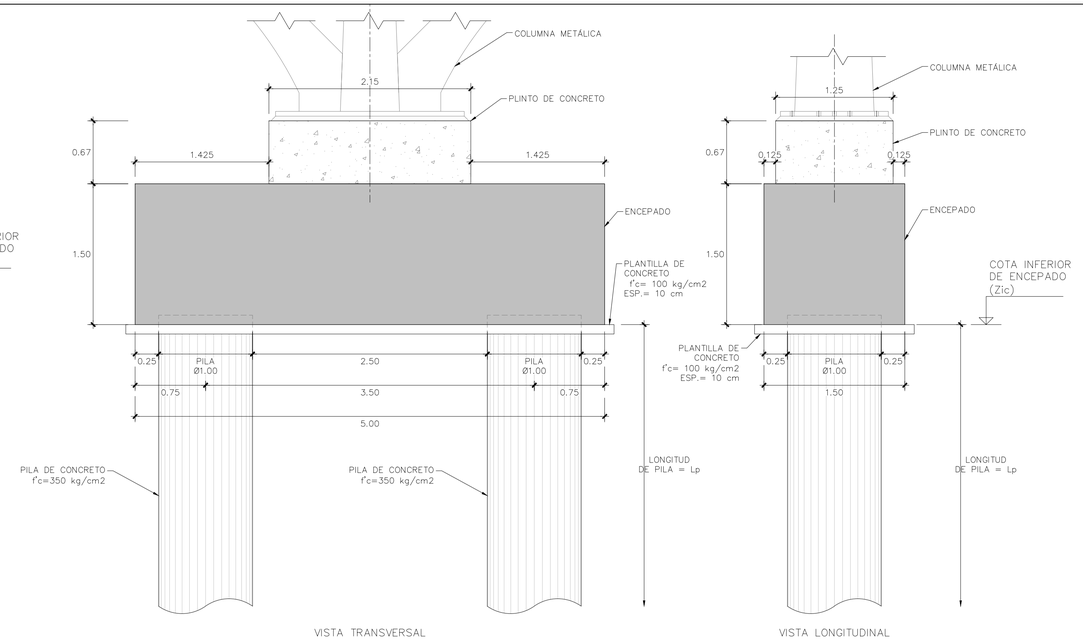
DGOT-20-EST-III-0010-00211-P-00



VISTA TRANSVERSAL

VISTA LONGITUDINAL

CIMENTACIÓN TIPO C–I
ESCALA 1:30



VISTA TRANSVERSAL

VISTA LONGITUDINAL

CIMENTACIÓN TIPO C–II (COLUMNAS 9 Y 10)
ESCALA 1:30

VISTA TRANSVERSAL

VISTA LONGITUDINAL

VISTA TRANSVERSAL

VISTA LONGITUDINAL

PLANTA

CIMENTACIÓN COLUMNAS 7 Y 8
ESCALA 1:30

PLANTA

CIMENTACIÓN COLUMNA 11
ESCALA 1:30

CIMENTACIÓN DE COLUMNAS
CLASIFICACIÓN Y DIMENSIÓN DE PILAS Y PLINTOS

COLUMNA	CIMENTACIÓN TIPO	LONG. PILAS (Lp)	ANCHO PLINTO (Ap)	ALTURA PLINTO (Hp) (*2)	COTA. INF. ENCEPADO (Zic)
COL - 1	C-I	22.2	1.45	0.92	2269.68
COL - 2	C-I	19.9	1.50	0.47	2269.92
COL - 3	C-I	17.7	1.45	1.02	2270.00
COL - 4	C-I	16.8	1.35	2.00	2269.90
COL - 5	C-I	15.7	1.40	1.92	2268.84
COL - 6	C-I	16.5	1.40	0.87	2269.60
COL - 7	(*1)	17.9	--	--	2270.99
COL - 8	(*1)	17.9	--	--	2270.99
COL - 9	C-II	16.7	--	--	2270.11
COL - 10	C-II	16.5	--	--	2269.87
COL - 11	(*1)	17.5	--	--	2270.64
COL - 12	C-I	15.6	1.40	0.67	2267.74
COL - 13	C-I	14.6	1.50	0.72	2265.59
COL - 14	C-I	14.0	1.60	1.12	2262.51
COL - 15	C-I	11.5	1.65	2.07	2260.01
COL - 16	C-I	12.0	1.55	2.42	2260.46

(*1) CIMENTACIONES ESPECIALES (VER GEOMETRÍAS REPRESENTADAS EN EL PRESENTE PLANO)
(*2) SE COMPROBARÁ QUE EN LA SITUACIÓN FINAL EL PARAMENTO SUPERIOR DEL PLINTO SOBRESALGA UN MÍNIMO DE 15 cm SOBRE LA COTA DEL TERRENO, DE MODO QUE ESTE MARGEN SIRVA COMO PROTECCIÓN PARA LAS COLUMNAS METÁLICAS ANTE LA HUMEDAD DEL SUELO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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PLANOS DE REFERENCIA
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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ADMINISTRADOR ÚNICO
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DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1400

CORresponsal ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CISE-0065

APROBÓ: M. I. DANIEL PÉREZ BELLO
REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA
PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA
DIBUJÓ: M.B.
OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CIMENTACIONES DE COLUMNAS
GEOMETRÍA

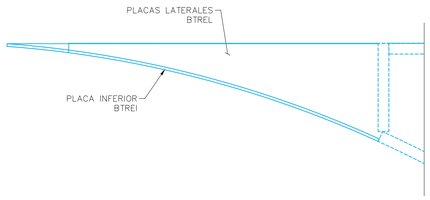
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

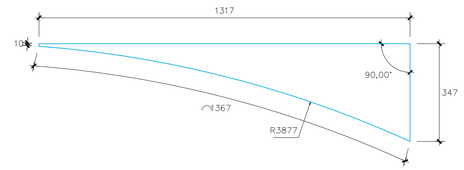
PLANO No.: **DGOT-20-EST-III-0013-00214-P-00**

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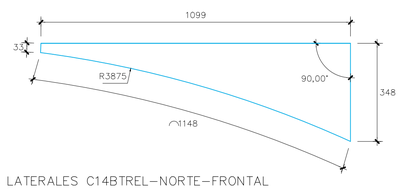
CONTROL	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		ESCALA: 1:30
		ESTRUCTURA	M.I. ARQEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
		GEOTECNIA	M.I. FRANCISCO PARAVICINI MEDINA		ACOT: METROS

DGOT-20-EST-III-0013-00214-P-00

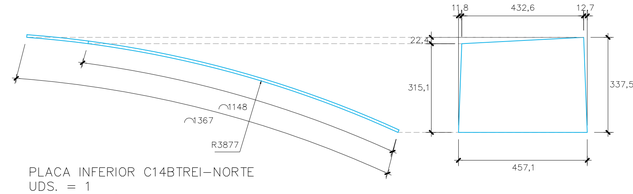




PLACAS LATERALES C14BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

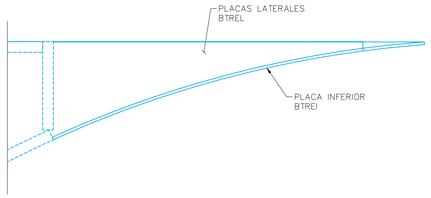


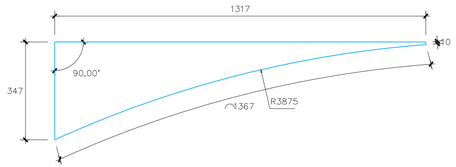
PLACAS LATERALES C14BTREL–NORTE–FRONTAL
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ESPESOR = ⅜"



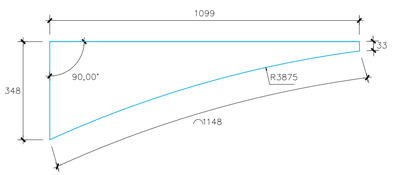
PLACA INFERIOR C14BTREI–NORTE
UDS. = 1
ESPESOR = ⅜"

COLUMNA 14 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10

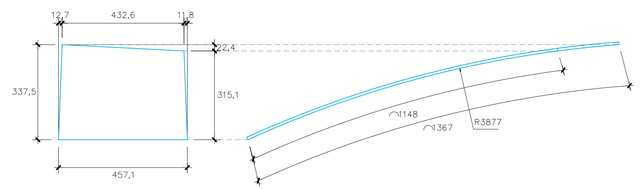




PLACAS LATERALES C14BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = ⅜"

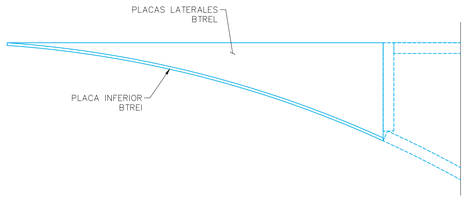


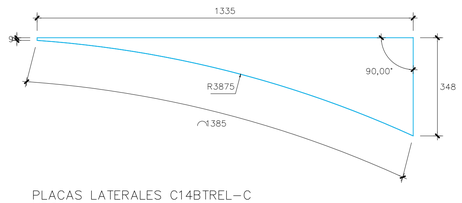
PLACAS LATERALES C14BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = ⅜"



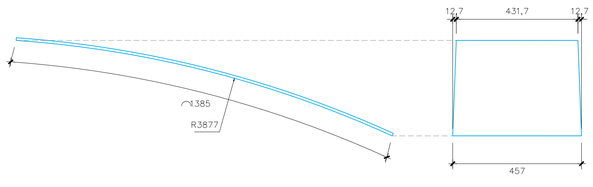
PLACA INFERIOR C14BTREI–SUR
UDS. = 1
ESPESOR = ⅜"

COLUMNA 14 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10



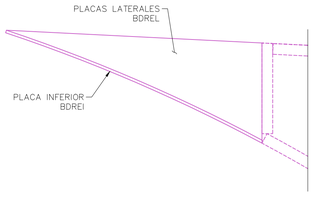


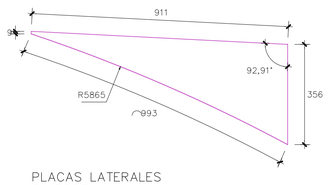
PLACAS LATERALES C14BTREL–C
UDS. = 4
ESPESOR = ⅜"



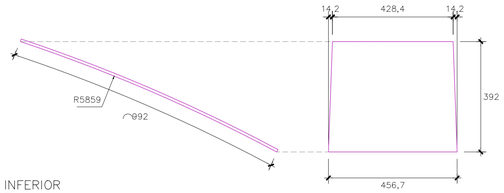
PLACA INFERIOR
C14BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 14
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



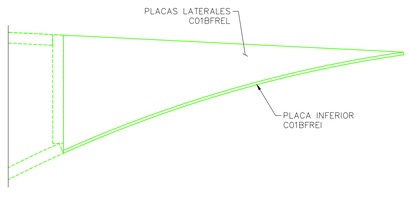


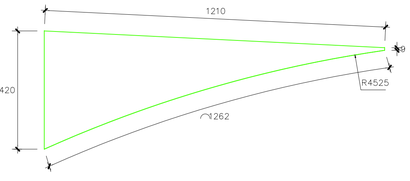
PLACAS LATERALES
C14BDREL
UDS. = 4
ESPESOR = ⅜"



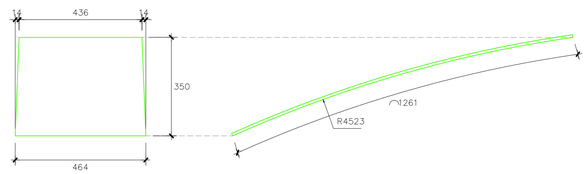
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ESPESOR = ⅜"

COLUMNA 14
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10





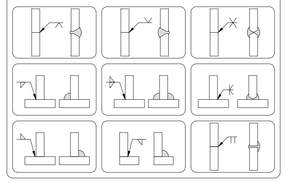
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ESPESOR = ⅜"



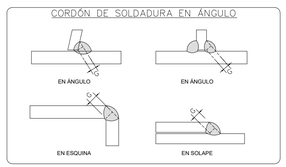
PLACA INFERIOR
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UDS. = 2
ESPESOR = ⅜"

COLUMNA 14
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

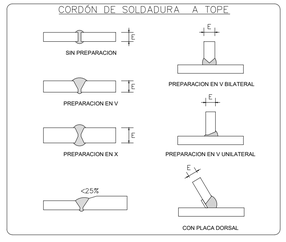
SIMBOLOGÍA Y RESULTADO

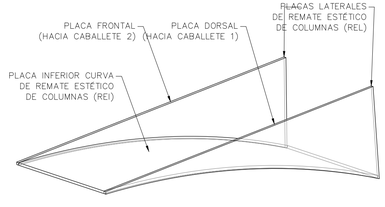


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

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CROQUIS DE TRAMO



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PLANOS DE REFERENCIA

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

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ING. ARQ. EDMUNDO REYES MADRID

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO

APROBÓ:
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REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 14. DESPIECE

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

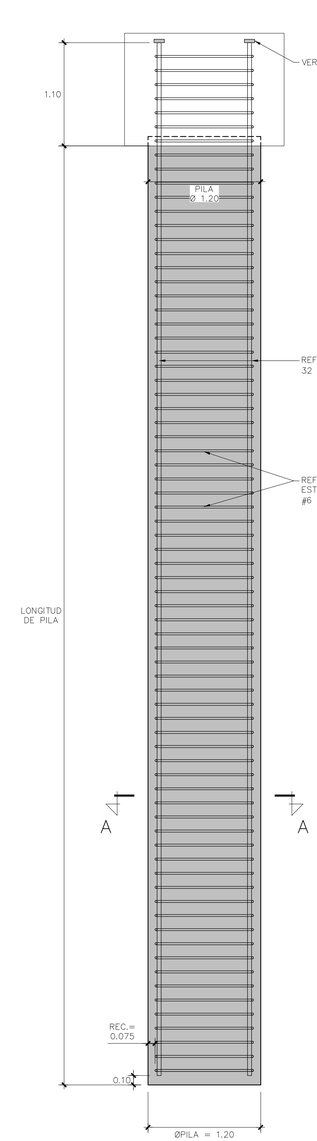
PLANO No.: DGOT-20-EST-III-0069-00270-P-00

ESCALA GRÁFICA: 0.1 0.3 0.5 1

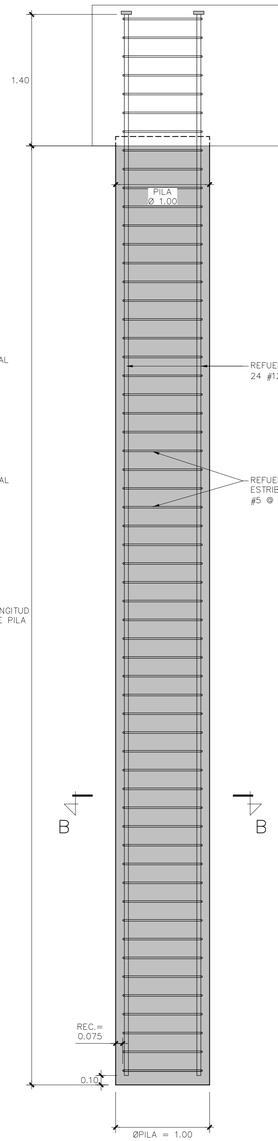
ESTUDIO	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:10
FECHA: JULIO 2021
ESC:
ACOT: METROS

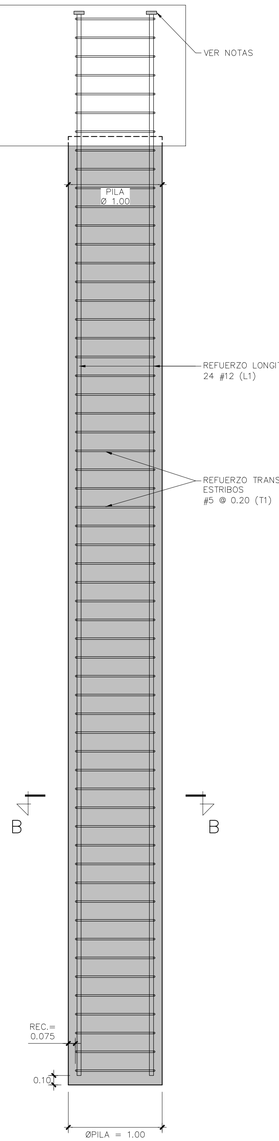
DGOT-20-EST-III-0069-00270-P-00

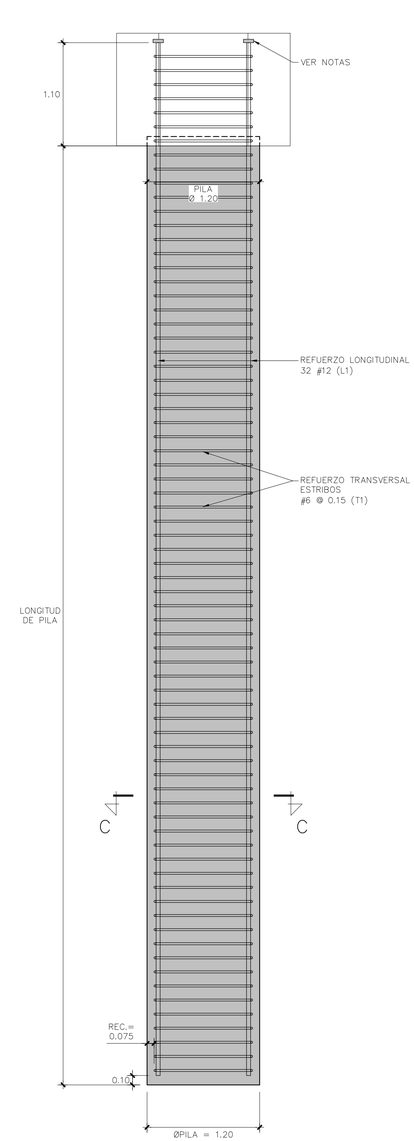


CIMENTACIÓN TIPO C–I



CIMENTACIÓN TIPO C–II





CIMENTACIÓN ESPECIAL (COLUMNAS 7, 8 Y 11)

CIMENTACIONES
REFUERZO DE PILAS. ALZADOS
ESCALA 1:30

PILAS. NOTAS ENCAMISADO

- DEBIDO A LA POSIBILIDAD DE INTERCEPTAR CON LAS PILAS LAS GALERÍAS PRESENTES EN LOS ESTRATOS Az Y Ap, DEBERÁ VALORARSE LA POSIBILIDAD DE QUE EN DETERMINADOS TRAMOS DE ALGUNAS PILAS SE DISPONGA ADEME METÁLICO PERDIDO, NO RECUPERABLE, PARA PERMITIR EL COLADO DE CONCRETO.
- EL RESPONSABLE DE GEOTECNIA DEBERÁ VALIDAR LA ELECCIÓN DE UN MÉTODO CONSTRUCTIVO U OTRO SEGÚN LAS CIRCUNSTANCIAS DEL SITIO.
- ADICIONALMENTE, EL RESPONSABLE DE GEOTECNIA REVISARÁ LAS RESISTENCIAS POR FRICCIÓN DEL TERRENO PARA VALIDARLAS O MODIFICARLAS (SI PROCEDE) ANTE EL EVENTUAL REEMPLAZO DE ADEME METÁLICO RECUPERABLE POR ADEME PERDIDO.

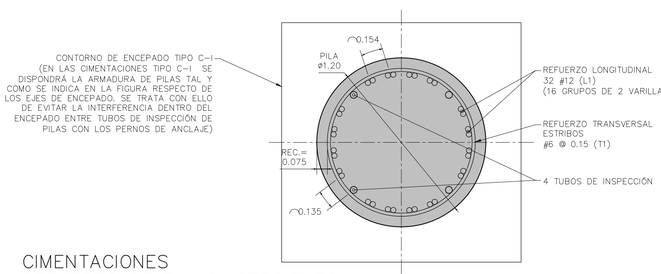
CONCRETO

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES EN EL PLANO DE NOTAS GENERALES.

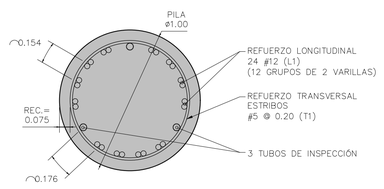
ACERO DE REFUERZO

- CONSULTAR LONGITUDES DE TRASLAPE, ANCLAJES Y OTROS DETALLES EN EL PLANO DE NOTAS GENERALES.
- LOS EMPALMES DE VARILLAS #10 Y#12 SE RESOLVERÁN MEDIANTE CONECTORES MECÁNICOS. SE ATENDERÁ A LAS ESPECIFICACIONES DEL FABRICANTE PARA GARANTIZAR QUE EL CONECTOR SELECCIONADO PERMITA LA TRANSFERENCIA DE LA CARGA MÁXIMA ENTRE LAS VARILLAS A EMPALMAR.
- EL ANCLAJE DE LAS VARILLAS DE REFUERZO PRINCIPAL DE LAS PILAS DENTRO DEL ENCEPADO SE RESOLVERÁ EMPLEANDO VARILLAS CON CABEZA EN T, CON ANCLAJES MECÁNICOS TIPO TERMINATOR O SIMILAR. SE ATENDERÁ A QUE EL SISTEMA EMPLEADO GARANTICE LA TRANSMISIÓN DE LAS CARGAS DEL CONCRETO EN LA SECCIÓN FINAL DE LAS VARILLAS.

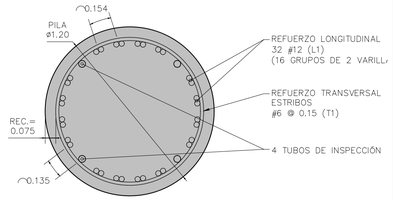
CIMENTACIONES
REFUERZO DE PILAS. SECCIONES
ESCALA 1:20



SECCIÓN A–A
CIMENTACIÓN TIPO C–I



SECCIÓN B–B
CIMENTACIÓN TIPO C–II



SECCIÓN C–C
COLUMNAS 7, 8 Y 11

COLUMNA	ESFUERZOS AXILES EN CABEZA DE PILAS					
	COMBINACIÓN DE SERVICIO		COMBINACIÓN DE RESISTENCIA		COMBINACIÓN EXTREMA	
	Compresión máxima (kN)	Tensión máxima (kN)	Compresión máxima (kN)	Tensión máxima (kN)	Compresión máxima (kN)	Tensión máxima (kN)
1	1570	-----	2020	-----	1630	-----
2	2780	-----	2910	-----	5480	-2470
3	2380	-----	3200	-----	2710	-----
4	2270	-----	3050	-----	2600	-----
5	2270	-----	3050	-----	2650	-----
6	2630	-----	2980	-----	5060	-2130
7	1620	-----	2110	-----	1670	-----
8	1660	-----	2160	-----	2550	-390
9	1430	-290	1430	-80	3110	-1890
10	1150	-10	1330	-----	2270	-1050
11	1610	-----	2090	-----	2230	-50
12	1800	-----	2390	-----	2640	-50
13	1820	-----	2380	-----	2960	-400
14	2510	-----	2800	-----	4710	-1700
15	2550	-----	3440	-----	2980	-----
16	2700	-----	2940	-----	4970	-1620

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRIDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1455

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0685

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CIMENTACIONES DE COLUMNAS
REFUERZO DE PILAS

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

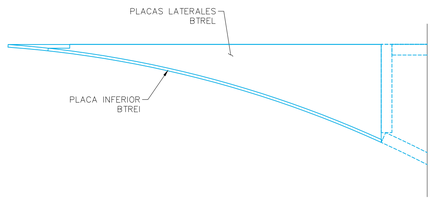
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DGOT-20-EST-III-0014-00215-P-00

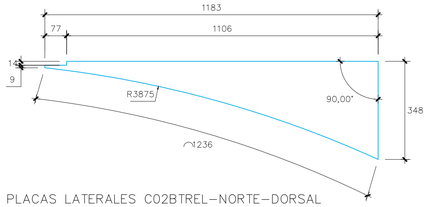
ESCALA GRÁFICA
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REVISÓ:	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	
	GEOTECNIA	M.I. FRANCISCO PANIAGUA MEDINA	

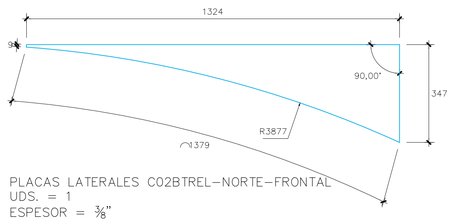
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FECHA: JULIO 2021
ESC:
ACOT.: METROS

DGOT-20-EST-III-0014-00215-P-00

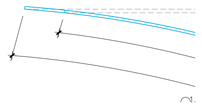




PLACAS LATERALES C02BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

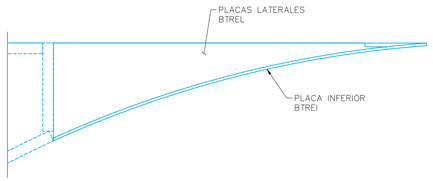


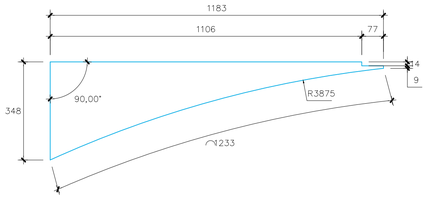
PLACAS LATERALES C02BTREL–NORTE–FRONTAL
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ESPESOR = ⅜"



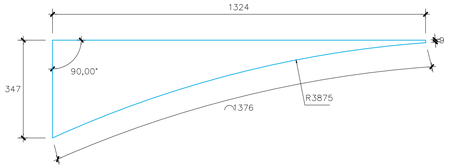
PLACA INFERIOR C02BTRI
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ESPESOR = ⅜"

COLUMNA 2 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10

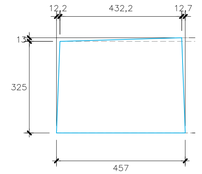




PLACAS LATERALES C02BTREL–SUR–DORSAL
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ESPESOR = ⅜"

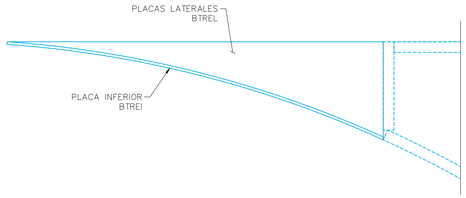


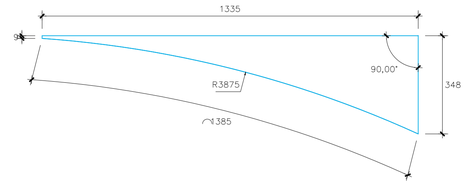
PLACAS LATERALES C02BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = ⅜"



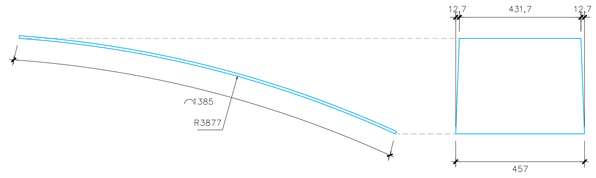
PLACA INFERIOR C02BTRI
UDS. = 1
ESPESOR = ⅜"

COLUMNA 2 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10



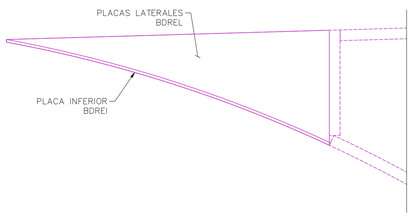


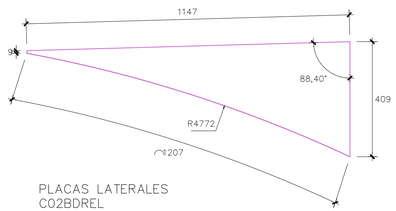
PLACAS LATERALES C02BTREL–C
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ESPESOR = ⅜"



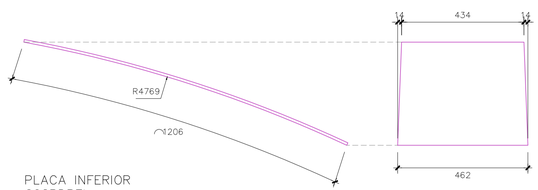
PLACA INFERIOR
C02BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 2
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



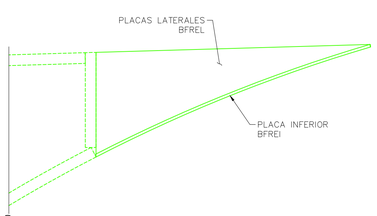


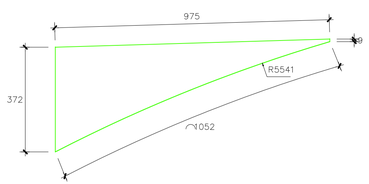
PLACAS LATERALES
C02BDREL
UDS. = 4
ESPESOR = ⅜"



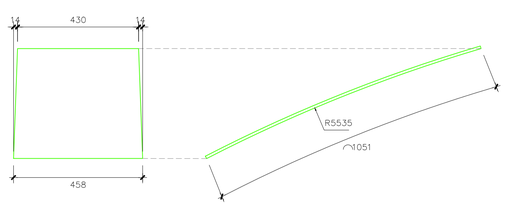
PLACA INFERIOR
C02BDREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 2
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10



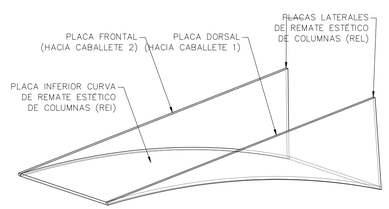


PLACAS LATERALES
C02BFREL
UDS. = 4
ESPESOR = ⅜"



PLACA INFERIOR
C02BFREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 2
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

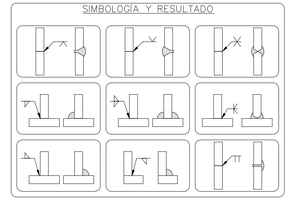


REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

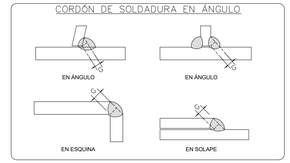
REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

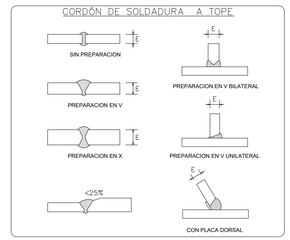
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
PREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 2. DESPIECE

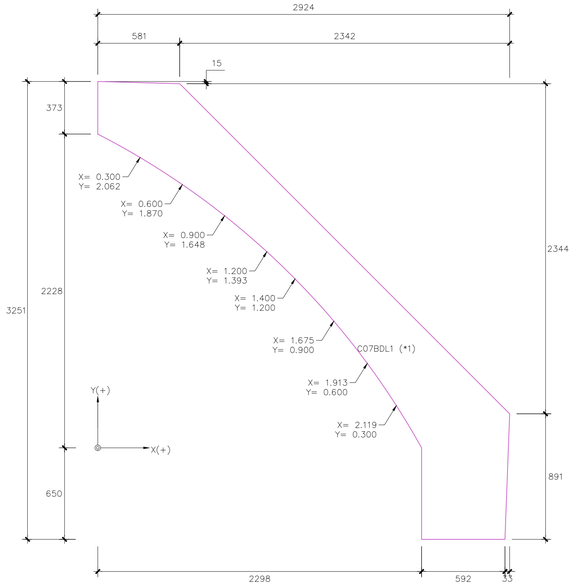
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0060-00261-P-00

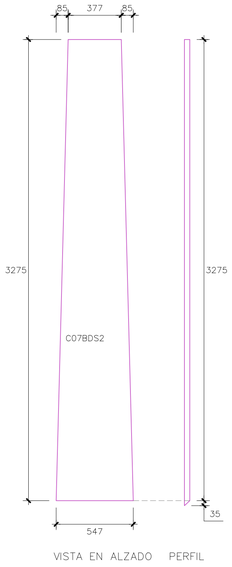
ESCALA GRÁFICA 0 0.1 0.3 0.5 1

FECHA:	DEPTO.	NOMBRE	FIRMA:	MOD: 1:10
	PROYECTO ESTRUCTURA	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
	ARQUITECTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC:
		M.C.A. JESUS IRVING CADENA PEREZ		ACOT: METROS

DGOT-20-EST-III-0060-00261-P-00

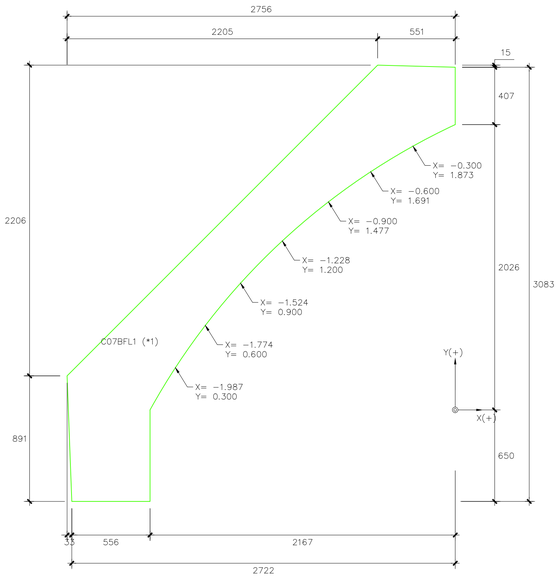


PLACAS
LATERALES
C07BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

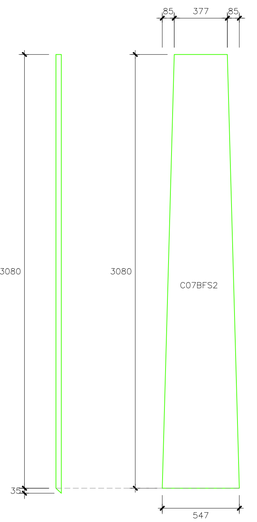


VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
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UDS. = 2
ESPESOR = 1 ½"

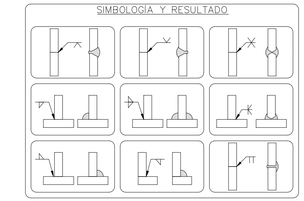


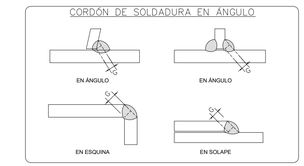
PLACAS
LATERALES
C07BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

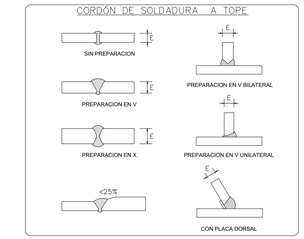


PERFIL VISTA EN ALZADO

PLACAS SUPERIORES
C07BFS2
UDS. = 2
ESPESOR = 1 ½"



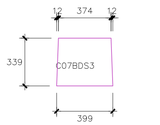




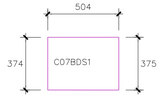


PLACAS INFERIORES
C07BDI1
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ESPESOR = 1 ½"

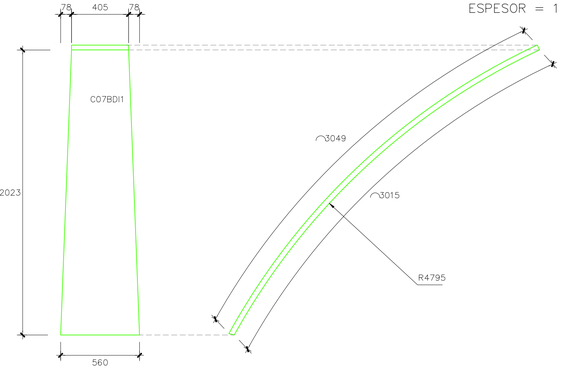
PERFIL VISTA EN ALZADO



PLACAS SUPERIORES
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ESPESOR = 1 ½"

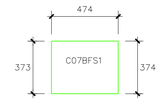


PLACAS SUPERIORES
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ESPESOR = 1 ½"

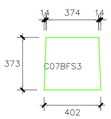


VISTA EN ALZADO PERFIL

PLACAS INFERIORES
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ESPESOR = 1 ½"

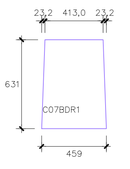


PLACAS SUPERIORES
C07BFS1
UDS. = 2
ESPESOR = 1 ½"

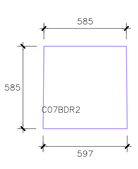


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ESPESOR = 1 ½"

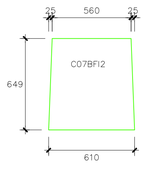
PLACAS INFERIORES
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ESPESOR = 1 ½"



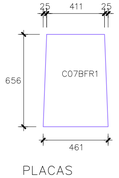
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RIGIDIZADORAS
C07BDR1
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ESPESOR = 1 ½"



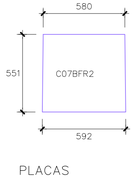
PLACAS
RIGIDIZADORAS
C07BDR2
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C07BFI2
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C07BFR1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C07BFR2
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 7
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

COLUMNA 7
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 7

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
PREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CVU 14265

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CVU 14265

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 7. DESPIECE (II)

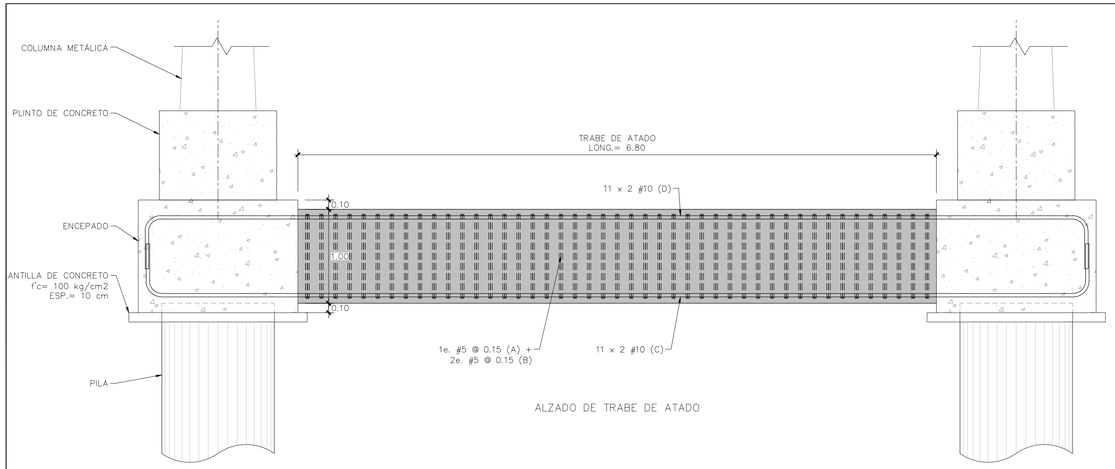
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0037-00238-P-00

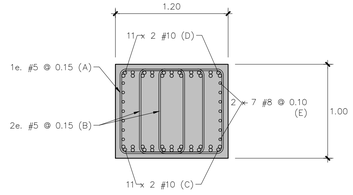
ESCALA GRÁFICA: 0 0.5 1

FECHA:	DEPTO.	NOMBRE	FIRMA	
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD: 1:20
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ESC:
				ACOT: METROS

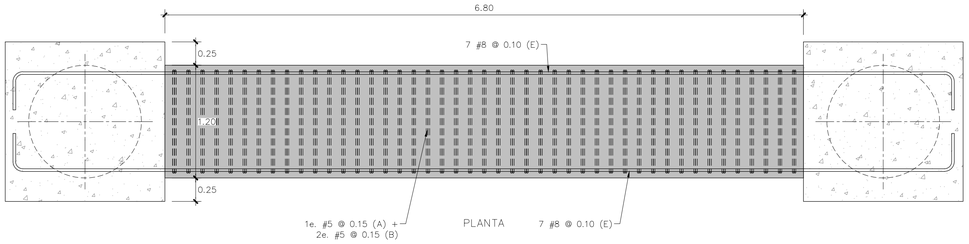
DGOT-20-EST-III-0037-00238-P-00



ALZADO DE TRABE DE ATADO



SECCIÓN TRANSVERSAL



PLANTA

TRABE DE ATADO ENTRE ENCEPADOS DE COLUMNAS 2, 6, 14 Y 16
GEOMETRÍA Y REFUERZO

ESCALA 1:30

CONCRETO

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES EN EL PLANO DE NOTAS GENERALES.

ACERO DE REFUERZO

- CONSULTAR LONGITUDES DE TRASLAPE, ANCLAJES Y OTROS DETALLES EN EL PLANO DE NOTAS GENERALES.
- LOS EMPALMES DE VARILLAS #10 Y#12 SE RESOLVERÁN MEDIANTE CONECTORES MECÁNICOS. SE ATENDERÁ A LAS ESPECIFICACIONES DEL FABRICANTE PARA GARANTIZAR QUE EL CONECTOR SELECCIONADO PERMITA LA TRANSFERENCIA DE LA CARGA MÁXIMA ENTRE LAS VARILLAS A EMPALMAR.
- EL ANCLAJE DE LAS VARILLAS DE REFUERZO PRINCIPAL DE LAS PILAS DENTRO DEL ENCEPADO SE RESOLVERÁ EMPLEANDO VARILLAS CON CABEZA EN T, CON ANCLAJES MECÁNICOS TIPO TERMINATOR O SIMILAR. SE ATENDERÁ A QUE EL SISTEMA EMPLEADO GARANTICE LA TRANSMISIÓN DE LAS CARGAS DEL CONCRETO EN LA SECCIÓN FINAL DE LAS VARILLAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRIDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1488

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE 0666

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

CIMENTACIONES DE COLUMNAS
COLUMNAS 2, 6, 14 Y 16
DEFINICIÓN DE TRABE DE ATADO

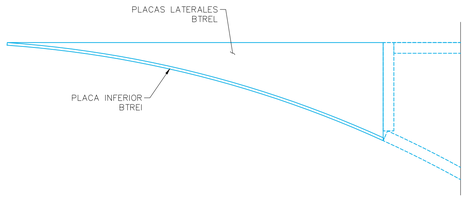
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

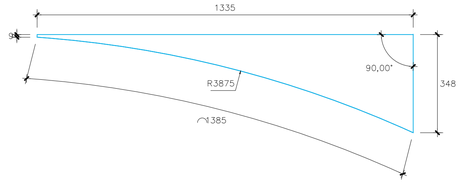
PLANO No.: **DGOT-20-EST-III-0016-00217-P-00**

ESCALA GRÁFICA: 0.3 0.9 1.5

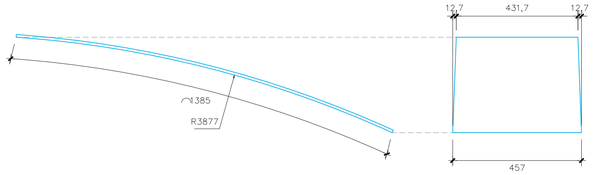
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:30
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ESC:
		GEOTECNIA	M.I. FRANCISCO PANIAGUA MEDINA		ACOT: METROS

DGOT-20-EST-III-0016-00217-P-00



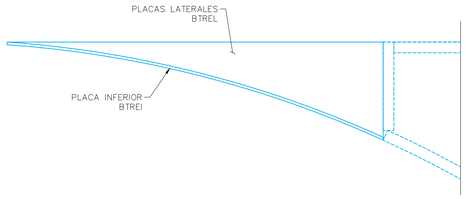


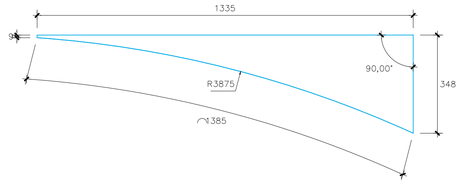
PLACAS LATERALES
C09BTREL
UDS. = 4
ESPESOR = ⅜"



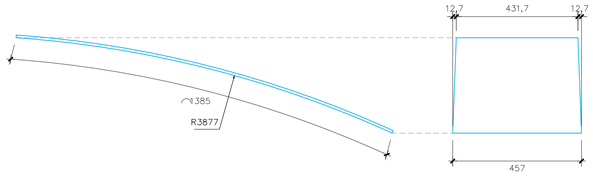
PLACA INFERIOR
C09BTREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 9
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10





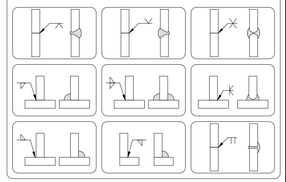
PLACAS LATERALES
C10BTREL
UDS. = 4
ESPESOR = ⅜"



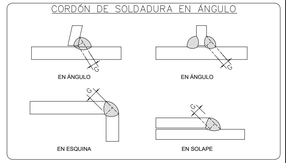
PLACA INFERIOR
C10BTREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 10
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10

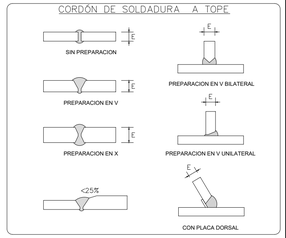
SIMBOLOGÍA Y RESULTADO

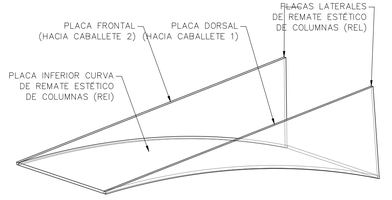


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
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DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A. DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1481

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDM-3661

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNAS 9 y 10. DESPIECE

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

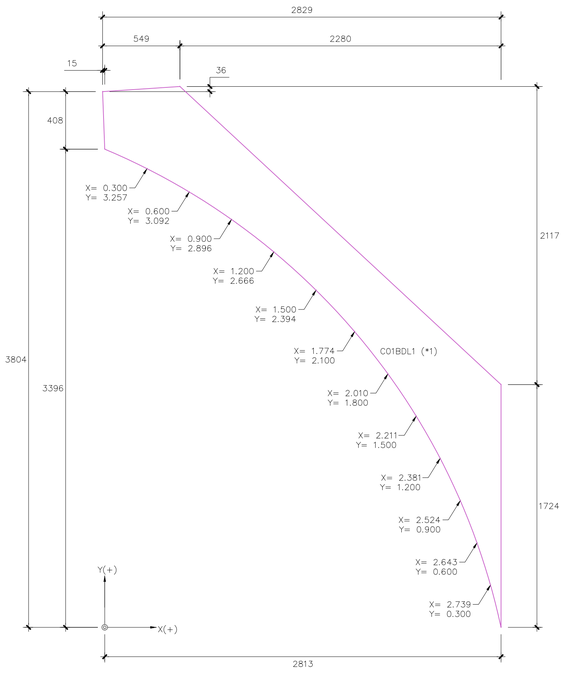
PLANO No.
DGOT-20-EST-III-0065-00266-P-00

ESCALA GRÁFICA
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REVISÓ	FECHA:	DEPTO.:	NOMBRE:	FIRMA:
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

MOD.: 1:10
FECHA: JULIO 2021
ESC.:
ACOT.: METROS

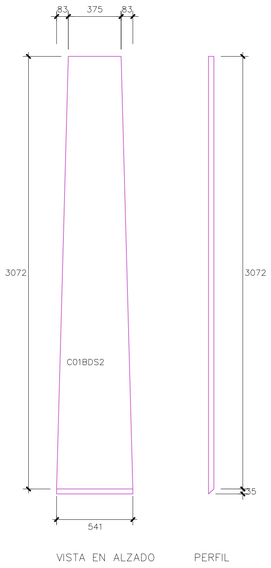
DGOT-20-EST-III-0065-00266-P-00



PLACAS
LATERALES
C01BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

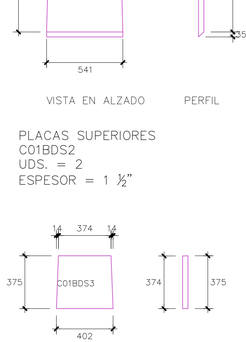
PLACAS INFERIORES
C01BDI1
UDS. = 2
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO



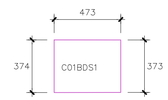
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
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ESPESOR = 1 ½"

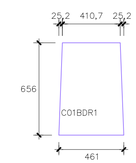


VISTA EN ALZADO PERFIL

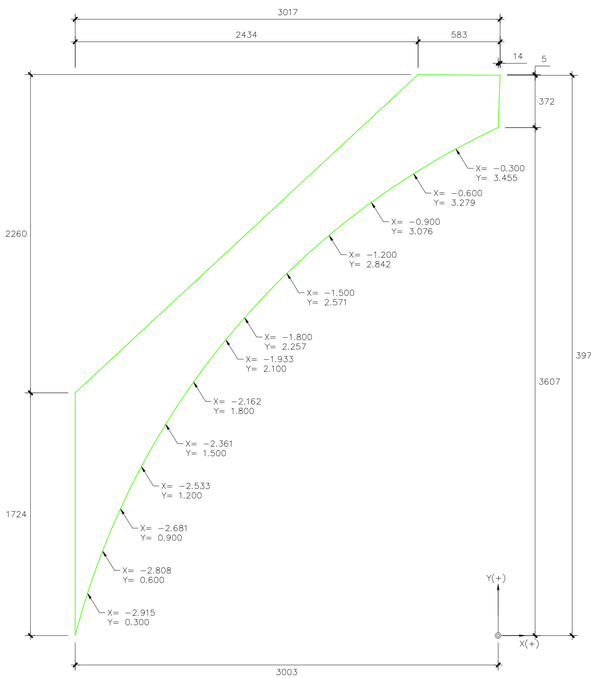
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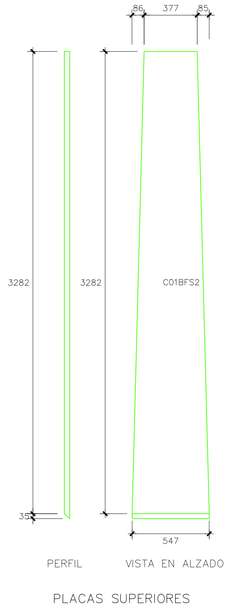
PLACAS SUPERIORES
C01BDS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C01BDR1
UDS. = 2
ESPESOR = 1 ½"

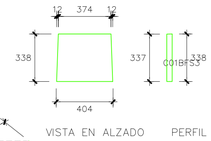


PLACAS
LATERALES
C01BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



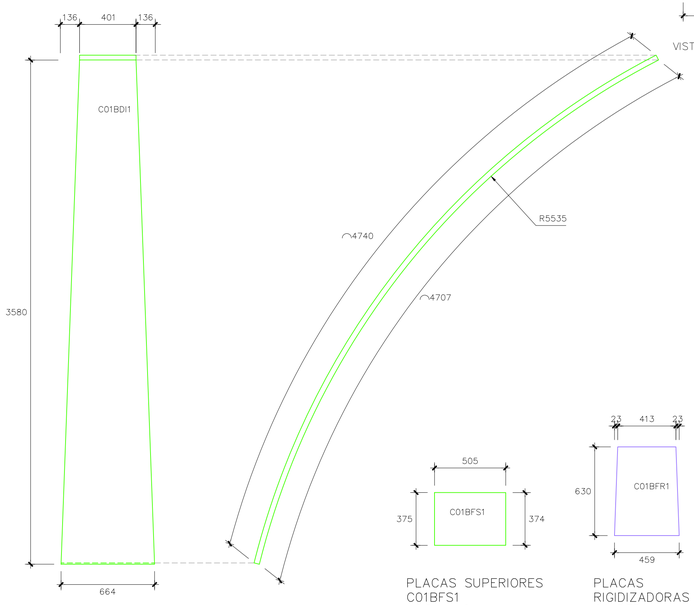
PERFIL VISTA EN ALZADO

PLACAS SUPERIORES
C01BFS2
UDS. = 2
ESPESOR = 1 ½"



VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C01BFS3
UDS. = 2
ESPESOR = 1 ½"



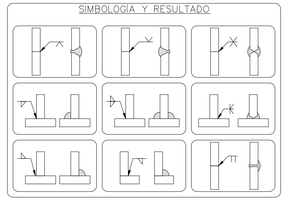
VISTA EN ALZADO PERFIL

PLACAS INFERIORES
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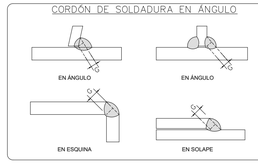
PLACAS SUPERIORES
C01BFS1
UDS. = 2
ESPESOR = 1 ½"

PLACAS
RIGIDIZADORAS
C01BFR1
UDS. = 2
ESPESOR = 1 ½"

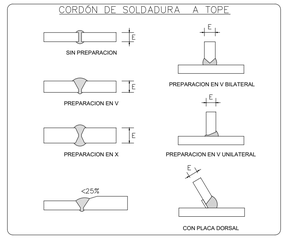
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

COLUMNA 1
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

COLUMNA 1
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1405

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0995

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 1. DESPIECE (II)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

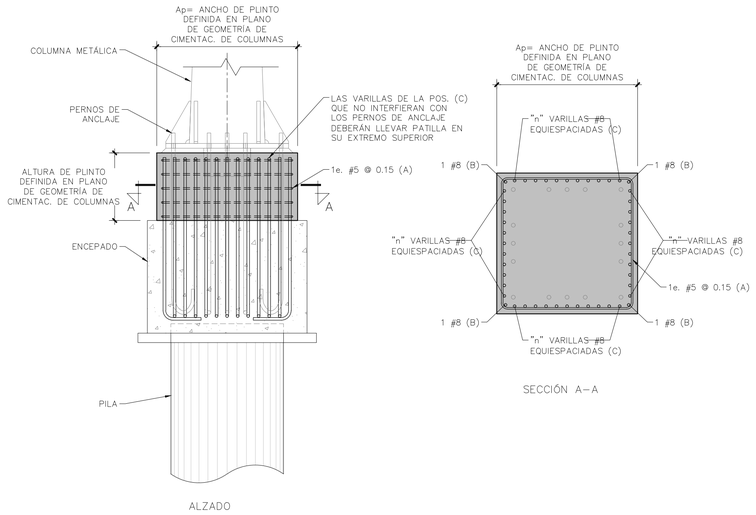
PLANO No.: **DGOT-20-EST-III-0026-00227-P-00**

ESCALA GRÁFICA: 0 0.5 1m

FECHA:	DEPTO.	NOMBRE	FIRMA
REVISÓ:	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT.: METROS

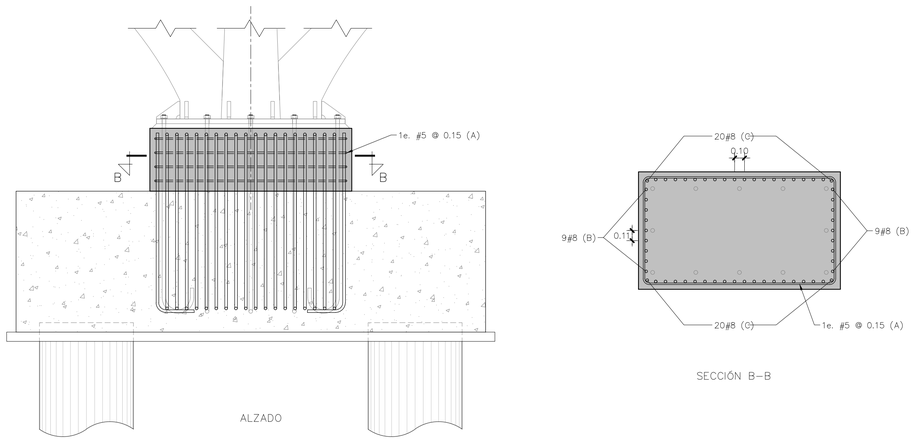
DGOT-20-EST-III-0026-00227-P-00



PLINTO EN CIMENTACIÓN C–I
POSICIÓN DE REFUERZO (C)
NÚMERO DE BARRAS SEGÚN ANCHO DE PLINTO

COLUMNA	ANCHO PLINTO (Ap)	NUM. VARILLAS "n"
COL - 1	1.45	11
COL - 2	1.50	11
COL - 3	1.45	11
COL - 4	1.35	10
COL - 5	1.40	10
COL - 6	1.40	10
COL - 7	--	--
COL - 8	--	--
COL - 9	--	--
COL - 10	--	--
COL - 11	--	--
COL - 12	1.40	10
COL - 13	1.50	11
COL - 14	1.60	12
COL - 15	1.65	13
COL - 16	1.55	12

PLINTOS DE CONCRETO
CIMENTACIÓN TIPO C–I
REFUERZO
ESCALA 1:30



PLINTOS DE CONCRETO
CIMENTACIÓN TIPO C–II
REFUERZO
ESCALA 1:30

CONCRETO

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES EN EL PLANO DE NOTAS GENERALES.

ACERO DE REFUERZO

- CONSULTAR LONGITUDES DE TRASLAPE, ANCLAJES Y OTROS DETALLES EN EL PLANO DE NOTAS GENERALES.
- LOS EMPALMES DE VARILLAS #10 Y#12 SE RESOLVERÁN MEDIANTE CONECTORES MECÁNICOS. SE ATENDERÁ A LAS ESPECIFICACIONES DEL FABRICANTE PARA GARANTIZAR QUE EL CONECTOR SELECCIONADO PERMITA LA TRANSFERENCIA DE LA CARGA MÁXIMA ENTRE LAS VARILLAS A EMPALMAR.
- EL ANCLAJE DE LAS VARILLAS DE REFUERZO PRINCIPAL DE LAS PILAS DENTRO DEL ENCEPADO SE RESOLVERÁ EMPLEANDO VARILLAS CON CABEZA EN T, CON ANCLAJES MECÁNICOS TIPO TERMINATOR O SIMILAR. SE ATENDERÁ A QUE EL SISTEMA EMPLEADO GARANTICE LA TRANSMISIÓN DE LAS CARGAS DEL CONCRETO EN LA SECCIÓN FINAL DE LAS VARILLAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PRIDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR ÚNICO
PRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1426

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0455

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
CIMENTACIONES DE COLUMNAS
REFUERZO DE PLINTOS

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

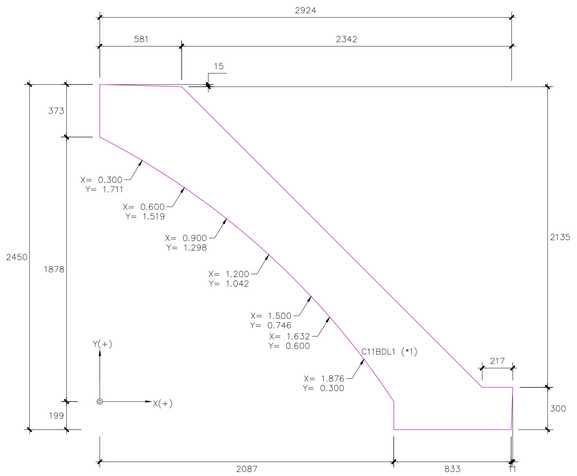
PLANO No.: **DGOT-20-EST-III-0012-00213-P-00**

ESCALA GRÁFICA: 0 0.3 0.9 1.5

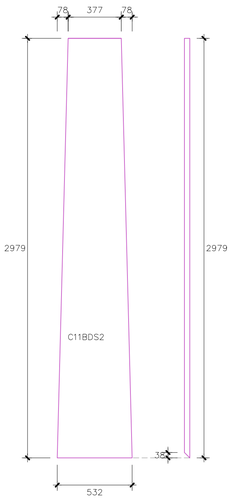
GESTIÓN	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	
		GEOTÉCNIA	M.I. FRANCISCO PANIAGUA MEDINA	

MOD.: 1:30
FECHA/H.: JULIO 2021
ESC.:
ACOT.: METROS

DGOT-20-EST-III-0017-00218-P-00

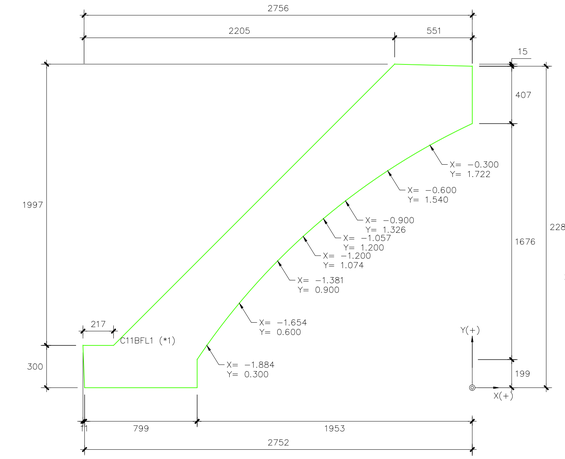


PLACAS
LATERALES
C11BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

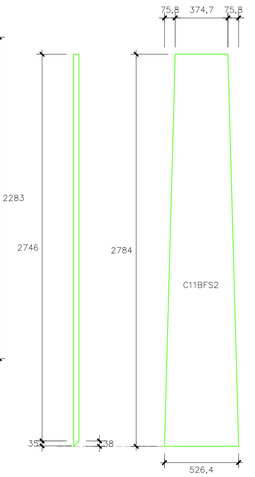


VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C11BDS2
UDS. = 2
ESPESOR = 1 ½"

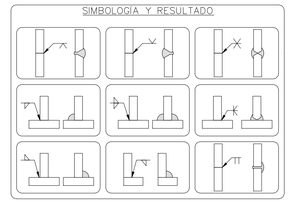


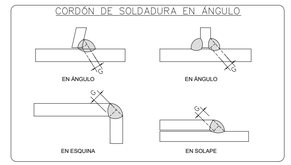
PLACAS
LATERALES
C11BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

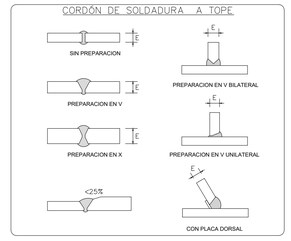


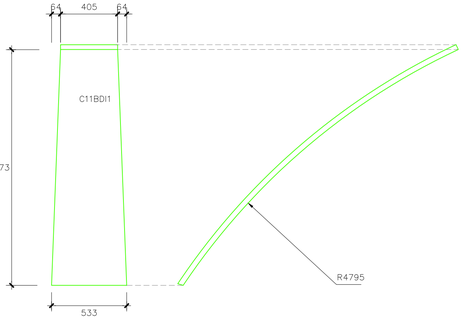
PERFIL VISTA EN ALZADO

PLACAS SUPERIORES
C11BFS2
UDS. = 2
ESPESOR = 1 ½"



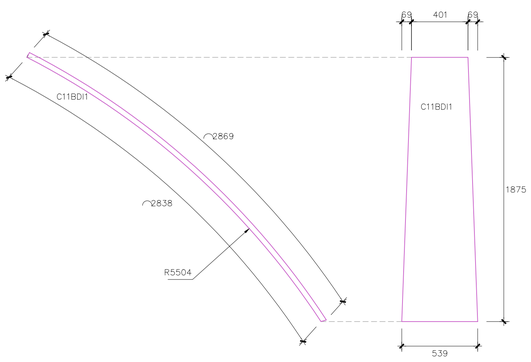






VISTA EN ALZADO PERFIL

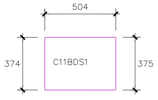
PLACAS INFERIORES
C11BDI1
UDS. = 2
ESPESOR = 1 ½"



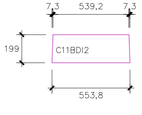
PERFIL VISTA EN ALZADO

PLACAS INFERIORES
C11BDI1
UDS. = 2
ESPESOR = 1 ½"

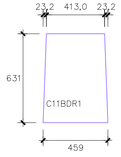
PLACAS SUPERIORES
C11BDS3
UDS. = 2
ESPESOR = 1 ½"



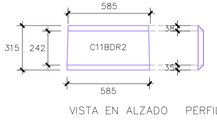
PLACAS SUPERIORES
C11BDS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C11BDI2
UDS. = 2
ESPESOR = 1 ½"

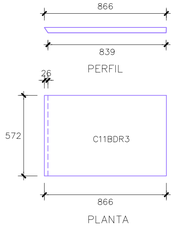


PLACAS
RIGIDIZADORAS
C11BDR1
UDS. = 2
ESPESOR = 1 ½"



VISTA EN ALZADO PERFIL

PLACAS
RIGIDIZADORAS
C11BDR2
UDS. = 2
ESPESOR = 1 ½"



PLANTA

PLACAS
RIGIDIZADORAS
C11BDR3
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 11
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

COLUMNA 11
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 11

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FIDEICOMISO DE INGENIERÍA Y ARQUITECTURA S.A DE C.V.
DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR UNICO FIDEIC. INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 14856

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CVE 14856

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TITULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 11. DESPIECE (II)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

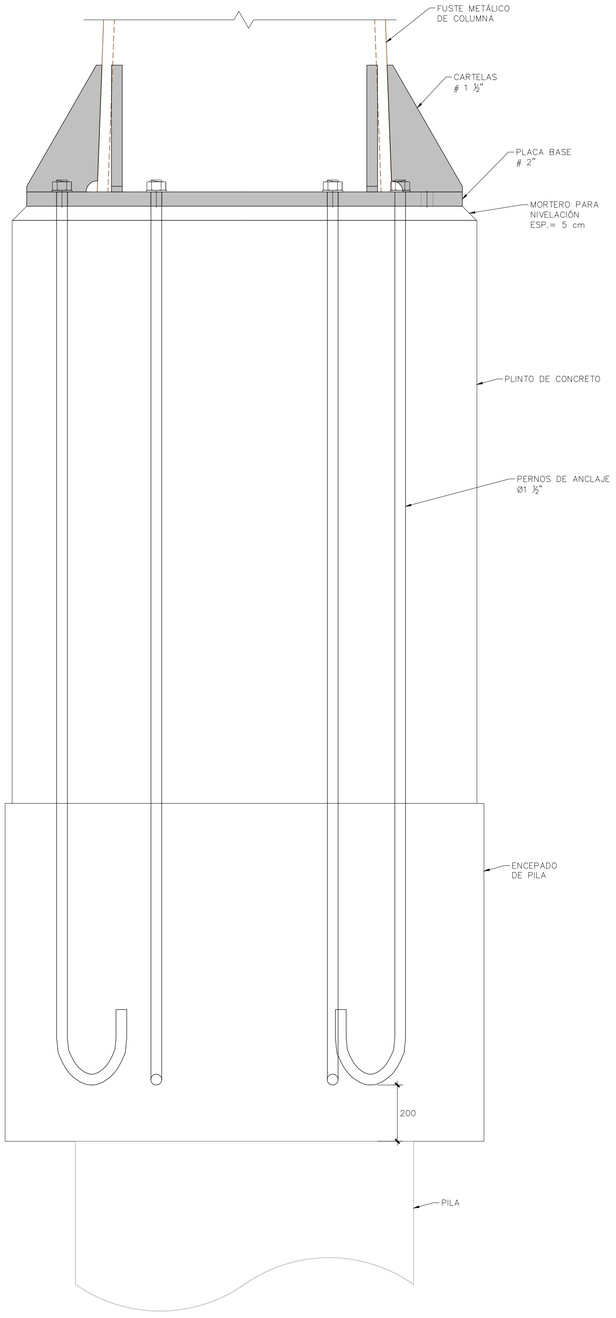
PLANO No:
DGOT-20-EST-III-0043-00244-P-00

ESCALA GRÁFICA: 0.5 0.8 1

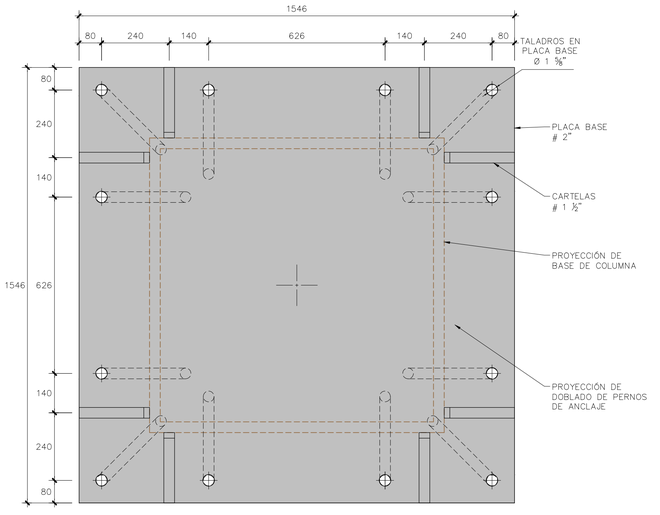
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

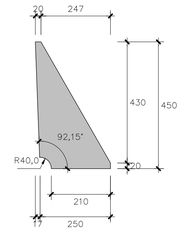
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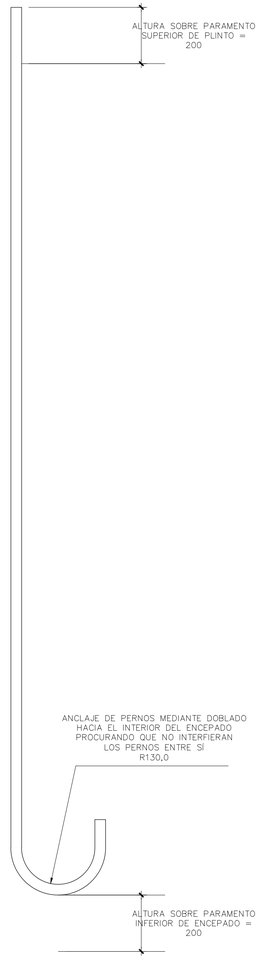
ALZADO



PLANTA
LA PLACA DE ANCLAJE SE SITÚA CENTRADA EN PLANTA SOBRE EL PLINTO CORRESPONDIENTE



(*) CARTELAS #1 ½"
8 UNIDADES POR PLACA



PERNOS DE ANCLAJE Ø1 ½"
12 UNIDADES POR PLACA

PLACA DE ANCLAJE= 1 UNIDAD

MATERIALES DE ELEMENTOS DE PLACAS DE ANCLAJE

- PLACAS ACERO A709 GR.50
- PERNOS DE ANCLAJE ACERO A490

PLACAS DE ANCLAJE EN CIMENTACIÓN DE COLUMNA 15 (TIPO C–I)
ESCALA 1:10

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
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APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

COLUMNAS METÁLICAS
PLACAS DE ANCLAJE A CIMENTACIONES (II)

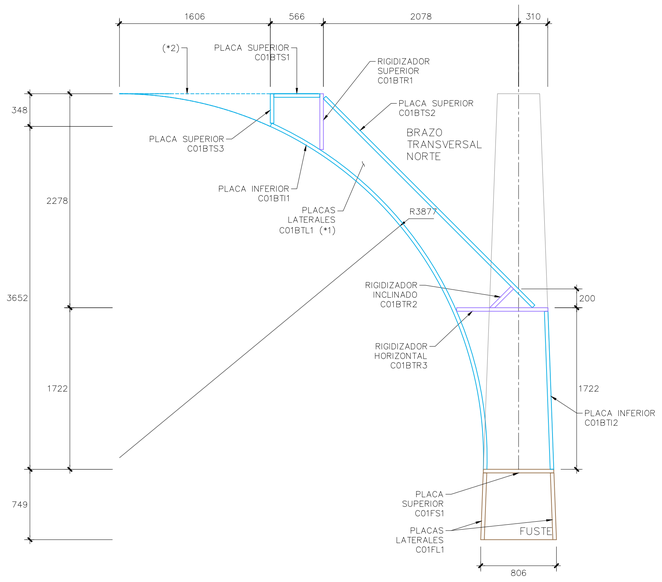
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0019-00220-P-00**

ESCALA GRÁFICA: 0.1 0.3 0.5 1

FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:10
	PROYECTO	M.I. INCIENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT: METROS

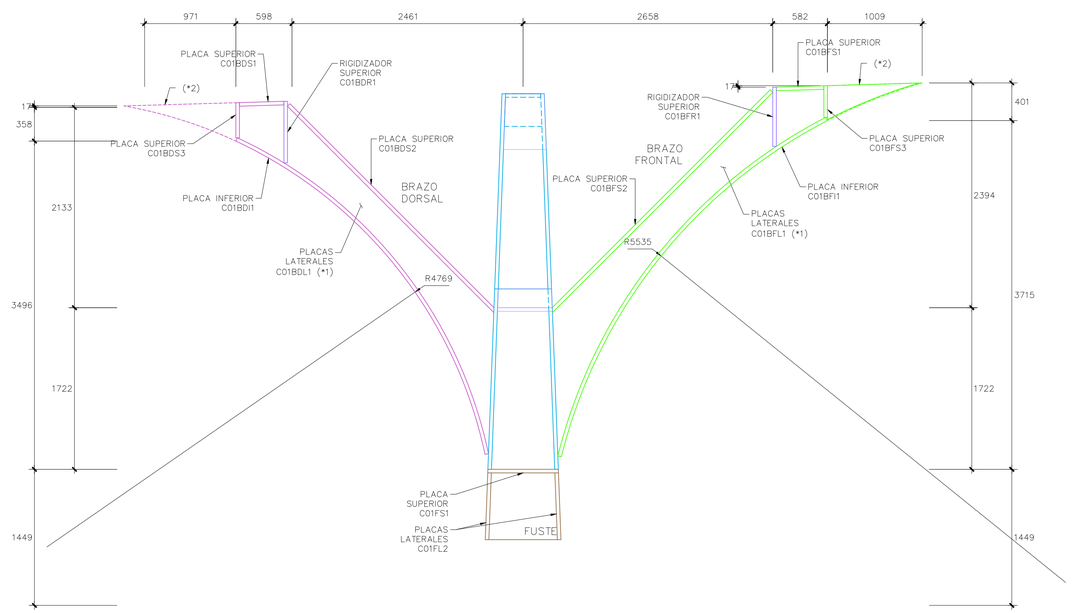
DGOT-20-EST-III-0019-00220-P-00



COLUMNA 1. SECCIÓN TRANSVERSAL

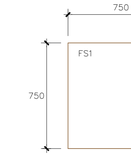
ESCALA 1:30

SE REPRESENTA LA COLUMNA 1 NORTE. IA COLUMNA 1 SUR ES SIMÉTRICA

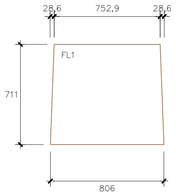


COLUMNA 1. SECCIÓN LONGITUDINAL (PDTE. DE CAJÓN= 2.88%)

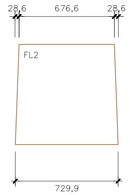
ESCALA 1:30



PLACA SUPERIOR
FS1
UDS. = 2
ESPESOR = 1 ½"



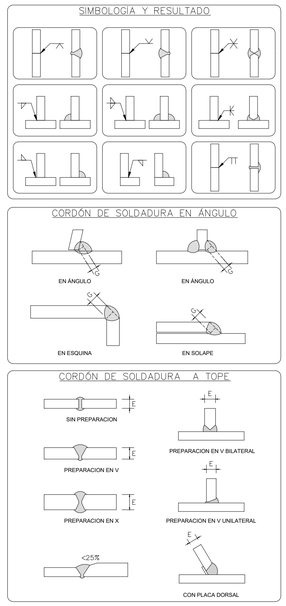
PLACAS
LATERALES FL1
UDS. = 4
ESPESOR = 1 ½"



PLACAS
LATERALES FL2
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 13
DESPIECE DE FUSTE

ESCALA 1:20



DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS

COLUMNA 1

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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SUBSECRETARÍA DE INFRAESTRUCTURA

REDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO.1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE-0885

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 1. VISTAS

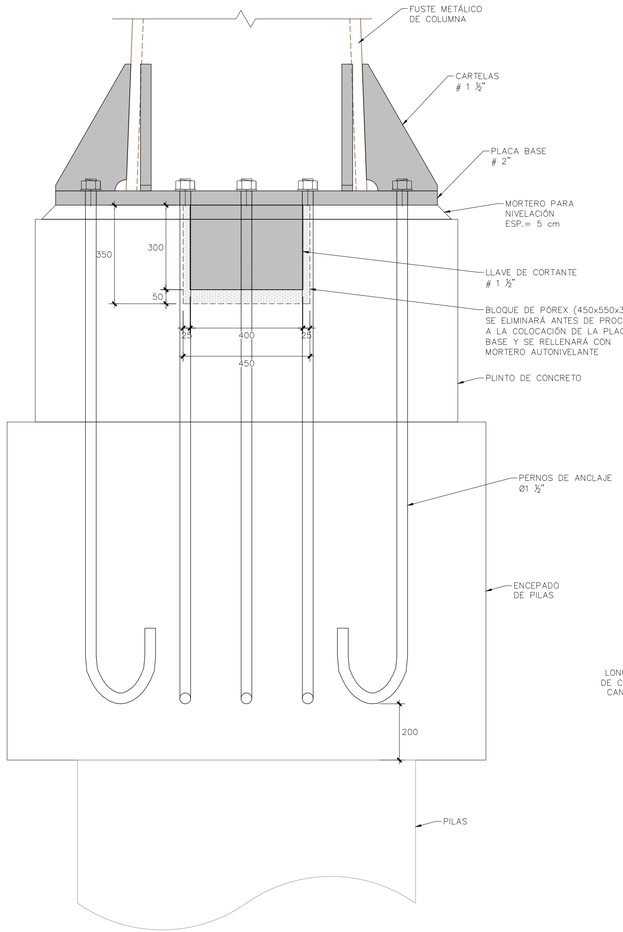
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0024-00225-P-00**

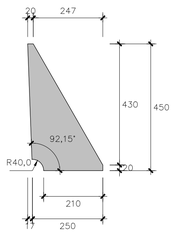
ESCALA GRAFICA: 0 8 16 24 32

FECHA:	DEPTO	NOMBRE	FIRMA	MOD.: 1:30
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT: METROS

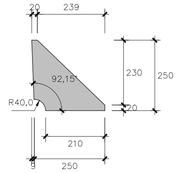
DGOT-20-EST-III-0024-00225-P-00



ALZADO
VISTA SEGÚN DIRECCIÓN LONGITUDINAL DE ESTRUCTURA

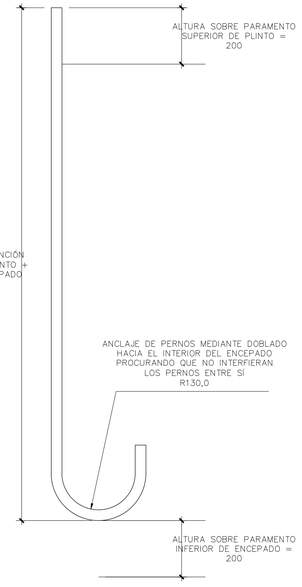


(*) CARTELAS #1 ½"
8 UNIDADES POR PLACA
(ESTA GEOMETRÍA NO ES VÁLIDA PARA LAS PLACAS DE LAS COLUMNAS 6 Y 12)

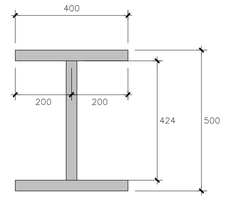


(*) CARTELAS #1 ½"
8 UNIDADES POR PLACA
(GEOMETRÍA PARA LAS PLACAS DE LAS COLUMNAS 6 Y 12)

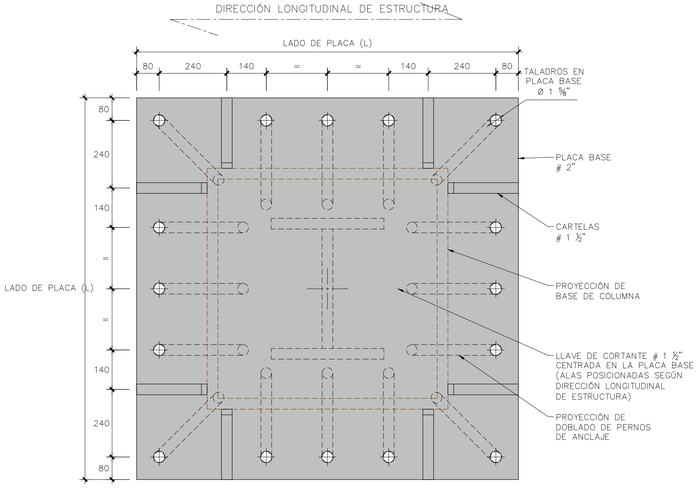
(*) (LAS CARTELAS PARA LAS PLACAS DE LAS COLUMAS 6 Y 12 TIENEN UNA GEOMETRÍA DIFERENTE PARA PODER ADAPTARSE A LOS BRAZOS DE LAS COLUMNAS)



PERNOS DE ANCLAJE Ø1 ½"
16 UNIDADES POR PLACA



LLAVE DE CORTANTE # 1 ½"



PLANTA
LA PLACA DE ANCLAJE SE SITÚA CENTRADA EN PLANTA SOBRE EL PLINTO CORRESPONDIENTE

COLUMNA	L (mm)	Uds / COL.
COL. 1	1306	2
COL. 2	1359	2
COL. 3	1347	1
COL. 4	1251	1
COL. 5	1295	1
COL. 6	1261	2
COL. 12	1261	2
COL. 13	1355	2
COL. 14	1494	2
COL. 16	1422	2

PLACAS DE ANCLAJE EN CIMENTACIONES TIPO C–I (EXCEPTO COLUMNA 15)
ESCALA 1:10

MATERIALES DE ELEMENTOS DE PLACAS DE ANCLAJE

- PLACAS ACERO A709 GR.50
- PERNOS DE ANCLAJE ACERO A490

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

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DRO-1466

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-1466

APROBÓ:
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REVISÓ:
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PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
PLACAS DE ANCLAJE A CIMENTACIONES (I)

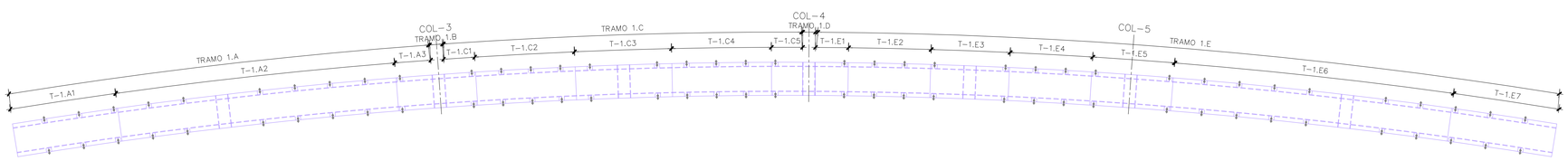
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: DGOT-20-EST-III-0018-00219-P-00

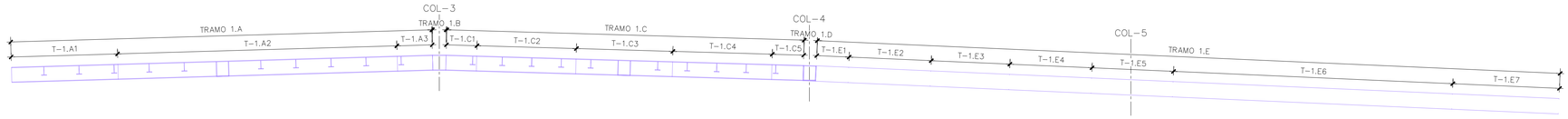
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ESCALA	FECHA	DEPTO.	NOMBRE	FIRMA	MOD: 1:10
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC:
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ACOT: METROS

DGOT-20-EST-III-0018-00219-P-00



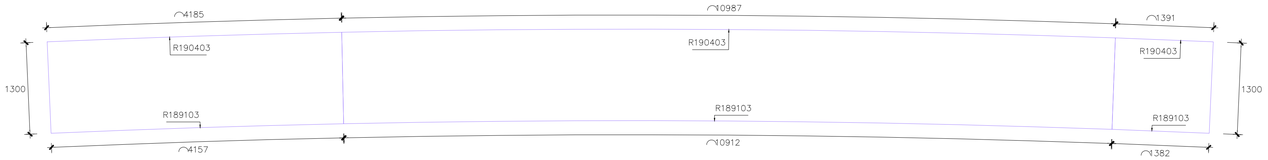
PLANTA



ALZADO

CAJÓN CENTRAL. TRAMO 1

ESCALA 1:100

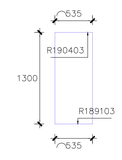


PLACA CCS-T1A1
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCS-T1A2
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCS-T1A3
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCS. PLANTA



PLACA CCS-T1B
UDS.= 1
ESPESOR= 7/8 "

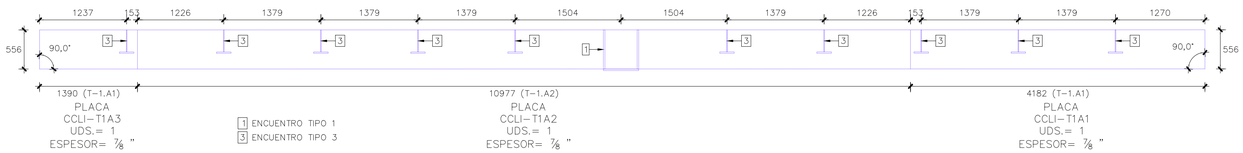
PLACAS CCS. PLANTA



PLACAS CCLI. PLANTA



PLACAS CCLI. PLANTA



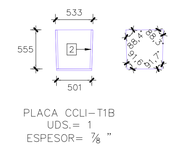
PLACA
CCLI-T1A3
UDS.= 1
ESPESOR= 7/8 "

1 ENCUENTRO TIPO 1
3 ENCUENTRO TIPO 3

PLACA
CCLI-T1A2
UDS.= 1
ESPESOR= 7/8 "

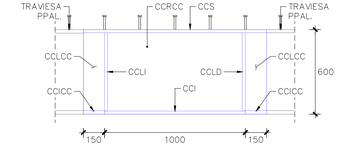
PLACA
CCLI-T1A1
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLI. ALZADO DESARROLLADO

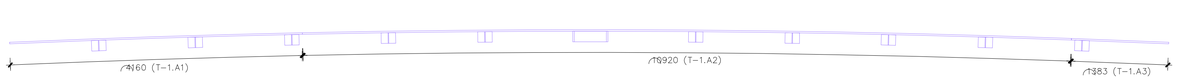


PLACA CCLI-T1B
UDS.= 1
ESPESOR= 7/8 "

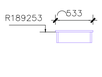
PLACAS CCLI. ALZADO DESARROLLADO



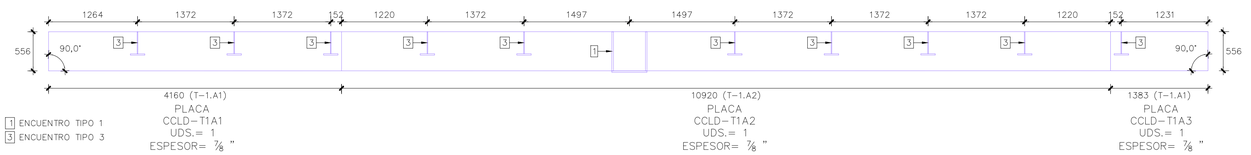
ENCUENTRO TIPO 1
ENCUENTRO CON TRAVIESA PPAL.
CENTRO DE CLARO



PLACAS CCLD. PLANTA



PLACAS CCLD. PLANTA



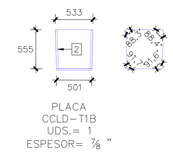
1 ENCUENTRO TIPO 1
3 ENCUENTRO TIPO 3

PLACA
CCLD-T1A1
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLD-T1A2
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLD-T1A3
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLD. ALZADO DESARROLLADO

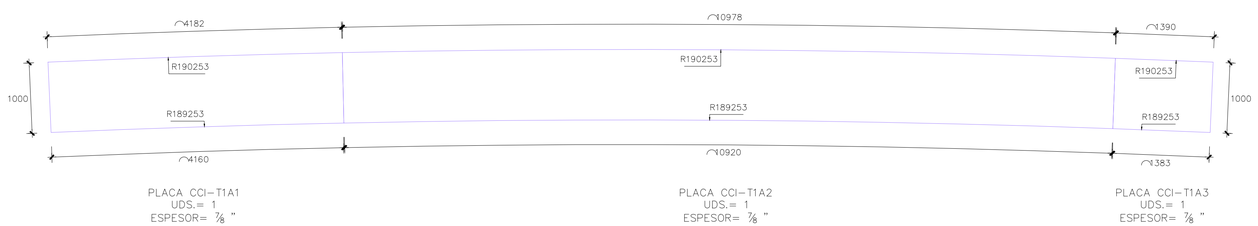


PLACA
CCLD-T1B
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLD. ALZADO DESARROLLADO



ENCUENTRO TIPO 2
ENCUENTRO CON TRAVIESA PPAL.
SOBRE COLUMNA



PLACA CCI-T1A1
UDS.= 1
ESPESOR= 7/8 "

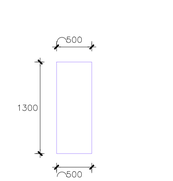
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UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T1A3
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 1.A

ESCALA 1:40

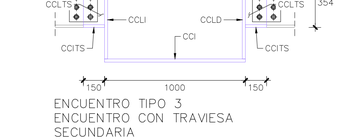


PLACA CCI-T1B
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 1.

ESCALA 1:40



ENCUENTRO TIPO 3
ENCUENTRO CON TRAVIESA
SECUNDARIA

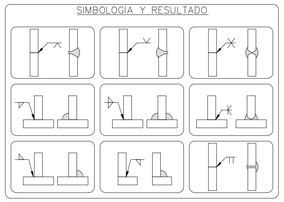
CAJÓN CENTRAL. SECCIONES TRANSVERSALES

ESCALA 1:20

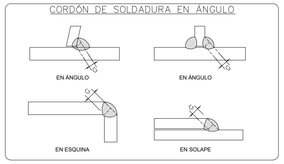
ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

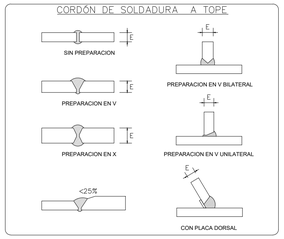
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
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4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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SECRETARIO DE OBRAS Y SERVICIOS
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CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
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PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA
CAJÓN CENTRAL (I)

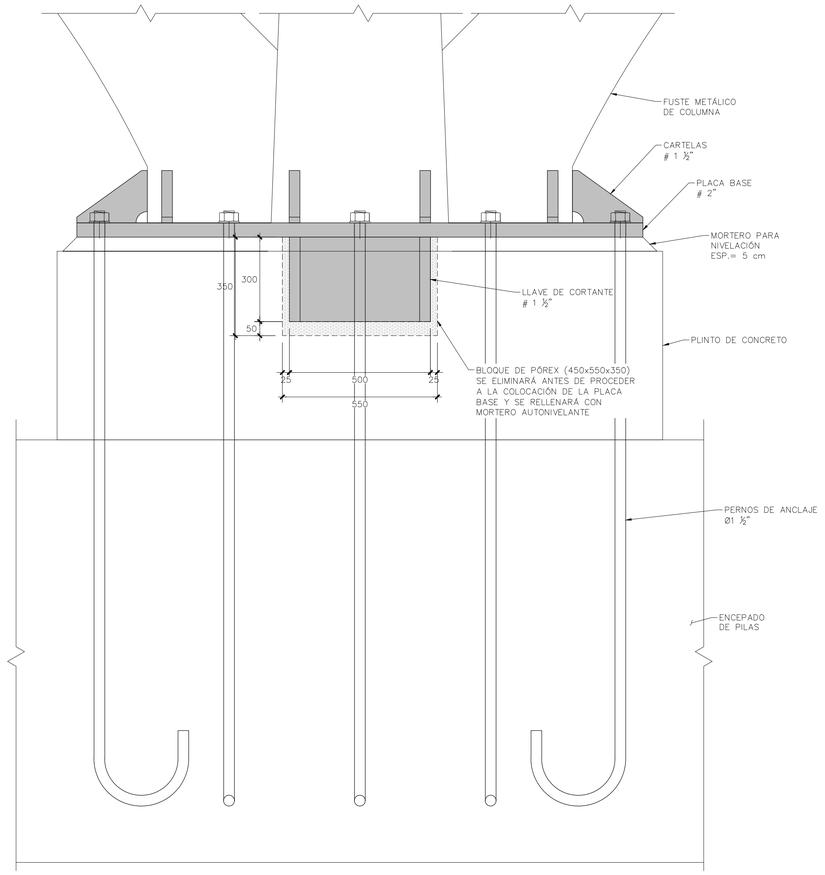
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0088-00289-P-00**

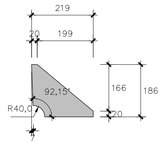
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REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO ESTRUCTURA	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:40
		ARQUITECTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
			M.C.A. JESÚS IRVING CADENA PÉREZ		ESC.
					ACOT. METROS

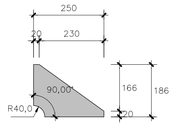
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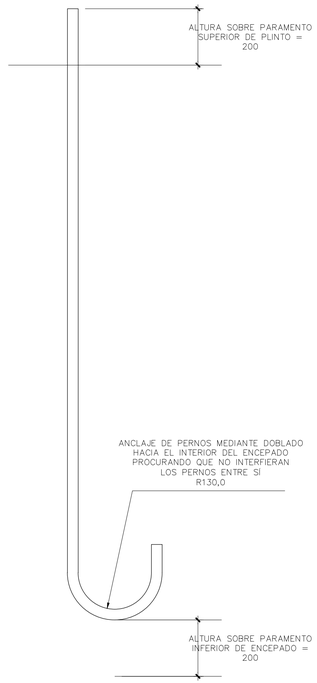
ALZADO
VISTA SEGÚN DIRECCIÓN TRANSVERSAL DE ESTRUCTURA



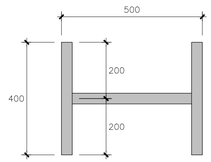
(*) CARTELAS #1 ½"
EN LADO LARGO DE PLACA
8 UNIDADES POR PLACA



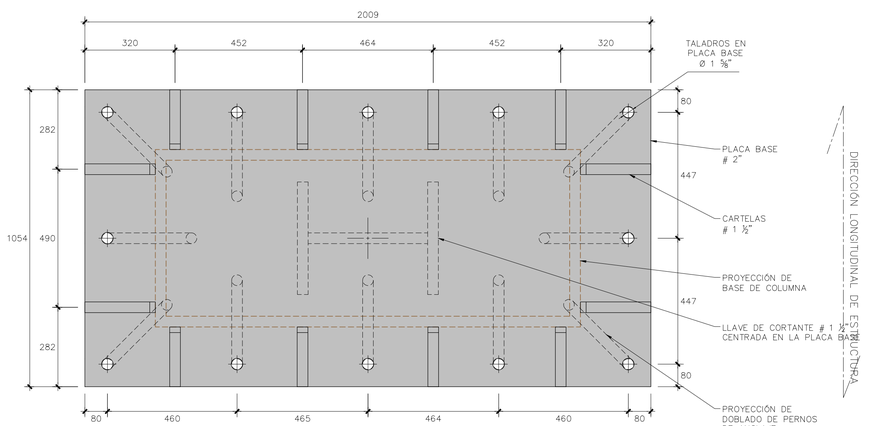
(*) CARTELAS #1 ½"
EN LADO CORTO DE PLACA
4 UNIDADES POR PLACA



PERNOS DE ANCLAJE Ø1 ½"
12 UNIDADES POR PLACA



LLAVE DE CORTANTE # 1 ½"



PLANTA
LA PLACA DE ANCLAJE SE SITÚA CENTRADA EN PLANTA SOBRE EL PLINTO CORRESPONDIENTE

PLACAS DE ANCLAJE= 1 UD. POR COLUMNA

PLACAS DE ANCLAJE EN CIMENTACIONES COLUMNAS 9 Y 10
ESCALA 1:10

MATERIALES DE ELEMENTOS DE PLACAS DE ANCLAJE

- PLACAS ACERO A709 GR.50
- PERNOS DE ANCLAJE ACERO A490

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FIEDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SANCHEZ

ADMINISTRADOR ÚNICO
FIEDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO.1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE.0985

APROBÓ:
M. I. DANIEL PÉREZ BELLO

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
PLACAS DE ANCLAJE A CIMENTACIONES (III)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

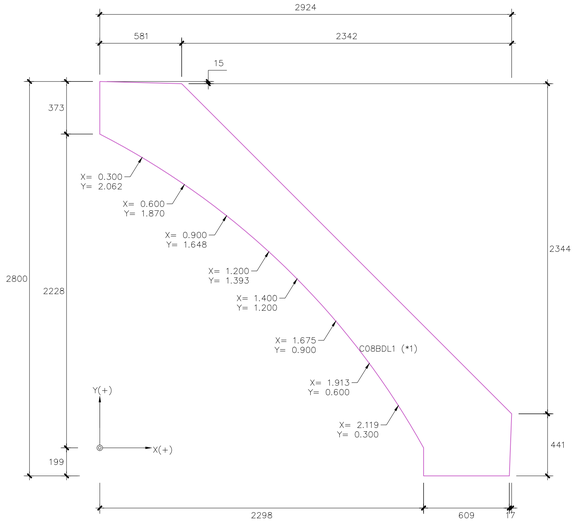
PLANO No.: **DGOT-20-EST-III-0020-00221-P-00**

ESCALA GRÁFICA: 0 0.1 0.3 0.6 1

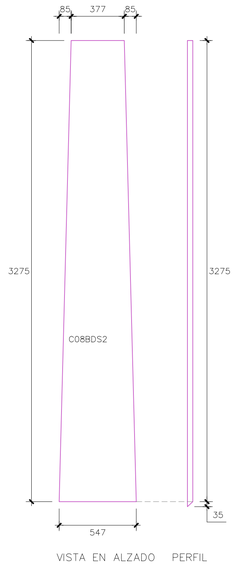
ESTRUCTURAS	FECHA	DEPTO	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD. 1:10
FECHA: JULIO 2021
ESC.
ACOT. METROS

DGOT-20-EST-III-0020-00221-P-00

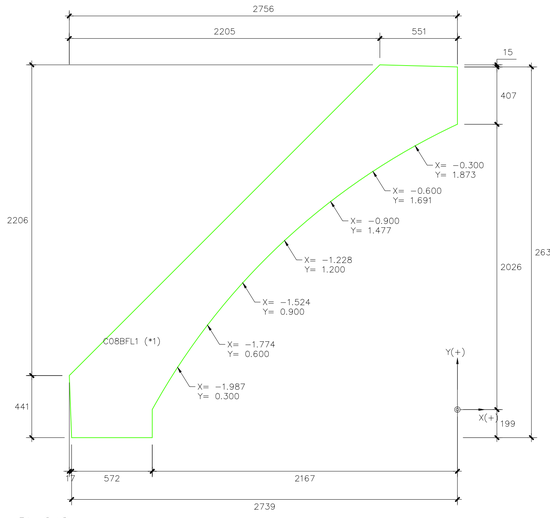


PLACAS
LATERALES
C08BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

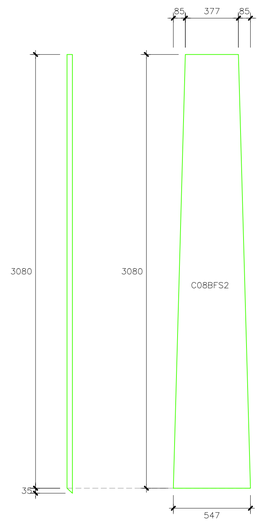


VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C08BDS2
UDS. = 2
ESPESOR = 1 ½"

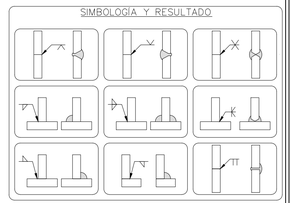


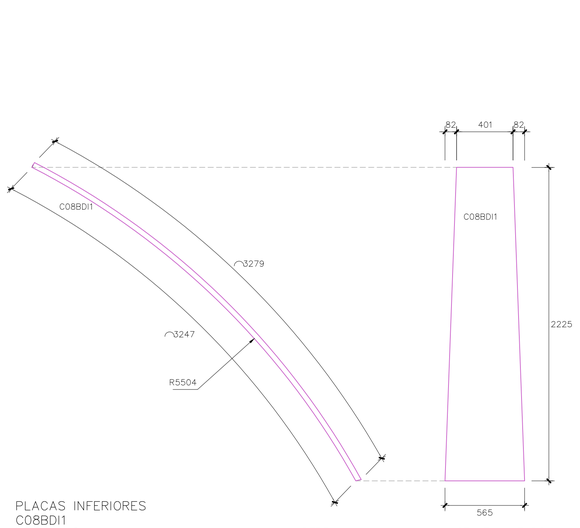
PLACAS
LATERALES
C08BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



PERFIL VISTA EN ALZADO

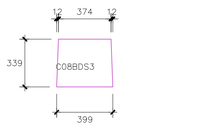
PLACAS SUPERIORES
C08BFS2
UDS. = 2
ESPESOR = 1 ½"



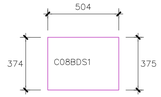


PLACAS INFERIORES
C08BDI1
UDS. = 2
ESPESOR = 1 ½"

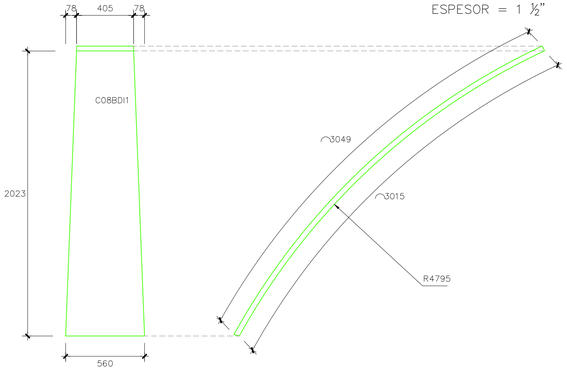
PERFIL VISTA EN ALZADO



PLACAS SUPERIORES
C08BDS3
UDS. = 2
ESPESOR = 1 ½"

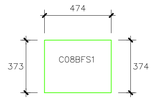


PLACAS SUPERIORES
C08BDS1
UDS. = 2
ESPESOR = 1 ½"

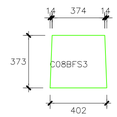


VISTA EN ALZADO PERFIL

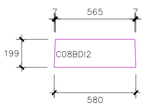
PLACAS INFERIORES
C08BFI1
UDS. = 2
ESPESOR = 1 ½"



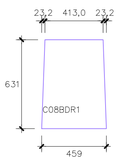
PLACAS SUPERIORES
C08BFS1
UDS. = 2
ESPESOR = 1 ½"



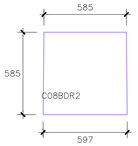
PLACAS SUPERIORES
C08BFS3
UDS. = 2
ESPESOR = 1 ½"



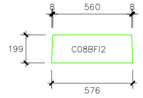
PLACAS INFERIORES
C08BDI2
UDS. = 2
ESPESOR = 1 ½"



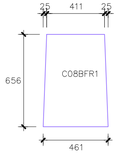
PLACAS
RIGIDIZADORAS
C08BDR1
UDS. = 2
ESPESOR = 1 ½"



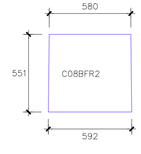
PLACAS
RIGIDIZADORAS
C08BDR2
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C08BFI2
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C08BFR1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C08BFR2
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 8
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

COLUMNA 8
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 8

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1455

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0945

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 8. DESPIECE (II)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

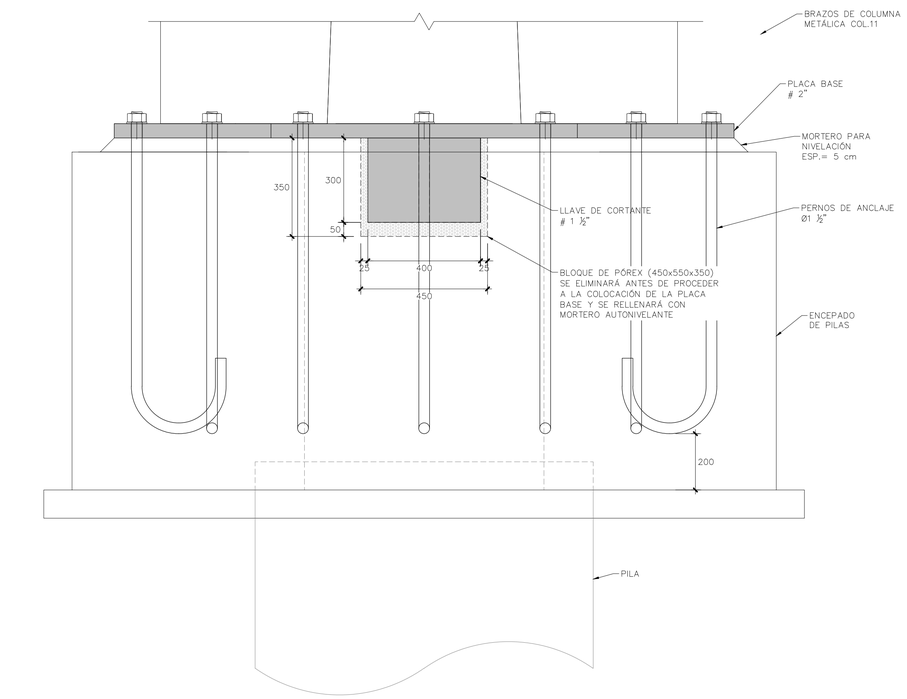
PLANO No:
DGOT-20-EST-III-0039-00240-P-00

ESCALA GRÁFICA: 0 0.5 1.0 1.5

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD.: 1:20
FECHA: JULIO 2021
ESC.:
ACOT.: METROS

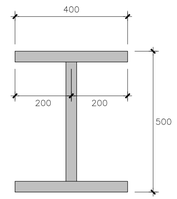
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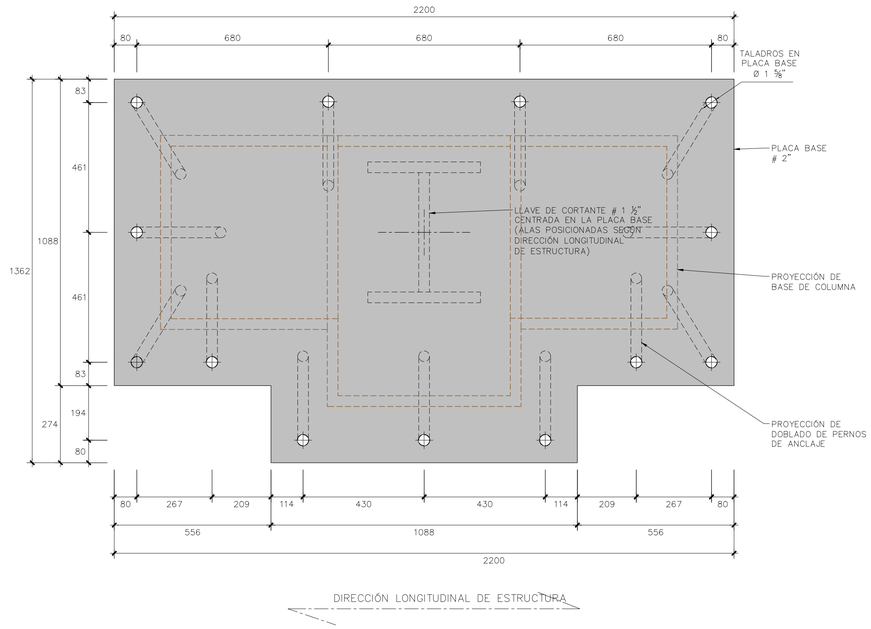
ALZADO
VISTA SEGÚN DIRECCIÓN LONGITUDINAL DE ESTRUCTURA



PERNOS DE ANCLAJE Ø1 ½"
13 UNIDADES POR PLACA



LLAVE DE CORTANTE # 1 ½"



PLANTA
LA PLACA DE ANCLAJE SE SITÚA CENTRADA EN PLANTA SOBRE EL ENCEPADO

PLACAS DE ANCLAJE= 2 UDs. POR COLUMNA

MATERIALES DE ELEMENTOS DE PLACAS DE ANCLAJE

- PLACAS ACERO A709 GR.50
- PERNOS DE ANCLAJE ACERO A490

PLACAS DE ANCLAJE EN CIMENTACIÓN DE COLUMNA 7
ESCALA 1:10

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1466

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CORRESPONSABLE

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

COLUMNAS METÁLICAS
PLACAS DE ANCLAJE A CIMENTACIONES (IV)

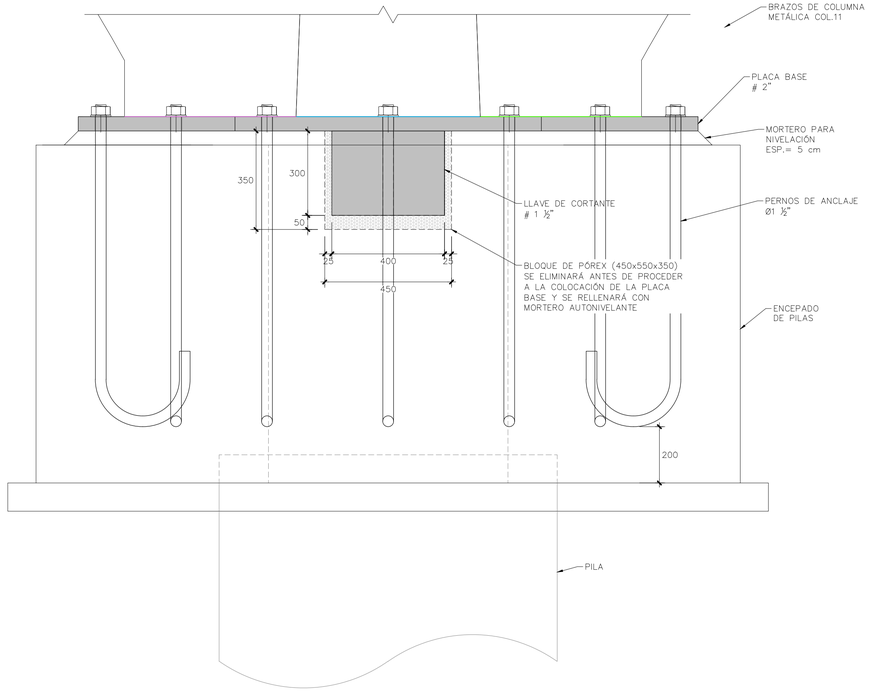
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0021-00222-P-00**

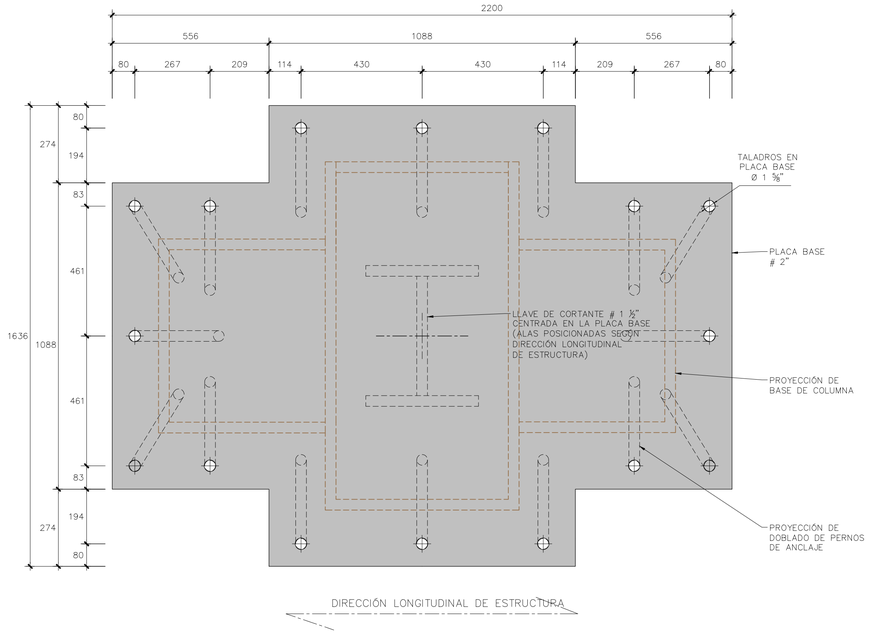
ESCALA GRÁFICA: 0.1 0.3 0.5 1

	FECHA	DEPTO.	NOMBRE	FIRMA	
ESCALA		PROYECTO ESTRUCTURA	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:10
		ARQUITECTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
			M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
					ACOT. METROS

DGOT-20-EST-III-0021-00222-P-00

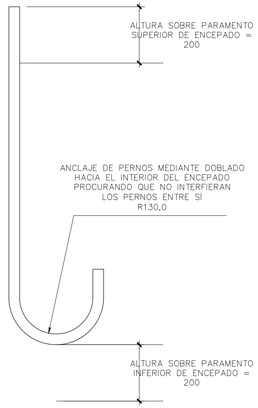


ALZADO
VISTA SEGÚN DIRECCIÓN LONGITUDINAL DE ESTRUCTURA

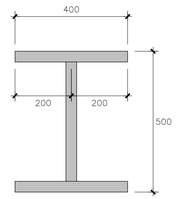


PLANTA
LA PLACA DE ANCLAJE SE SITÚA CENTRADA EN PLANTA SOBRE EL ENCEPADO

PLACAS DE ANCLAJE EN CIMENTACIÓN DE COLUMNA 8
ESCALA 1:10



PERNOS DE ANCLAJE Ø1 ½"
16 UNIDADES POR PLACA



LLAVE DE CORTANTE # 1 ½"

PLACAS DE ANCLAJE= 2 UDs. POR COLUMNA

MATERIALES DE ELEMENTOS DE PLACAS DE ANCLAJE

- PLACAS ACERO A709 GR.50
- PERNOS DE ANCLAJE ACERO A490

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

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ADMINISTRADOR ÚNICO
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DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

COLUMNAS METÁLICAS
PLACAS DE ANCLAJE A CIMENTACIONES (V)

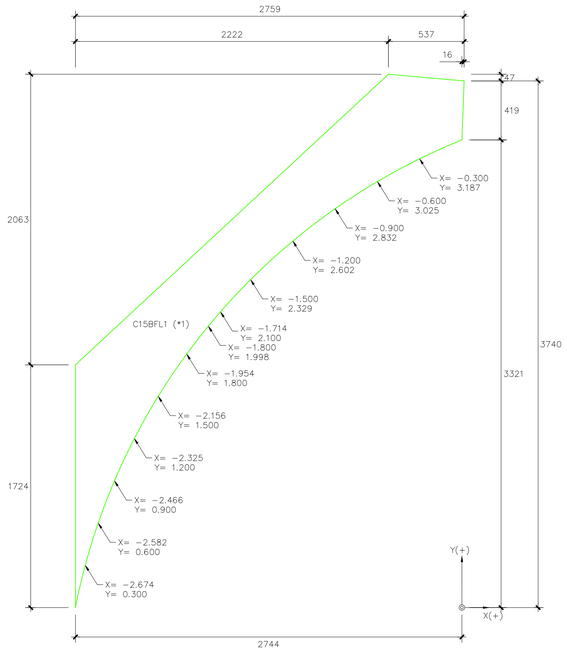
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0022-00223-P-00**

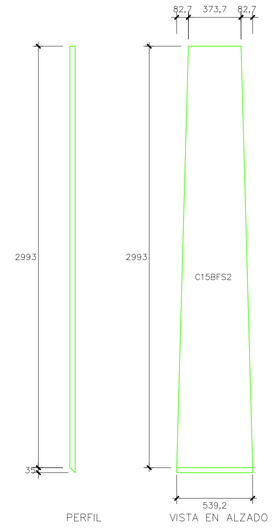
ESCALA GRÁFICA: 0.1 0.3 0.5 1

ESCALA	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:10
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ESC:
					ACOT. METROS

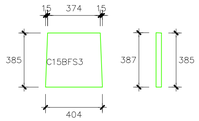
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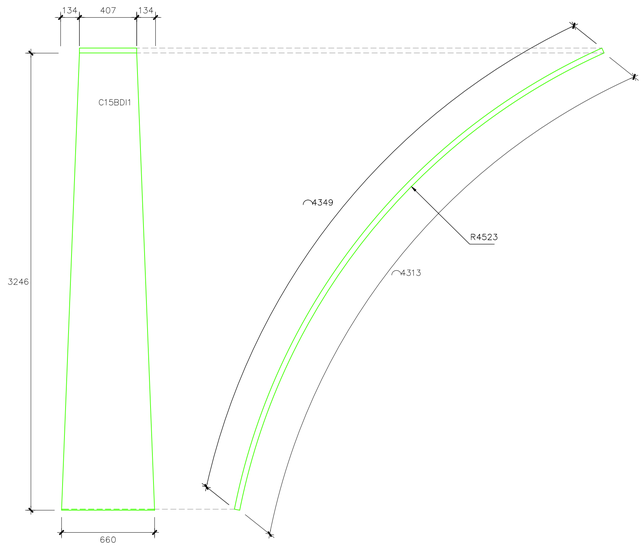
PLACAS
LATERALES
C15BFL1 (*1)
UDS. = 2
ESPESOR = 1 ½"



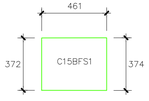
PLACAS SUPERIORES
C15BFS2
UDS. = 1
ESPESOR = 1 ½"



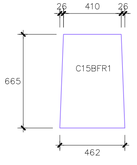
PLACAS SUPERIORES
C15BFS3
UDS. = 1
ESPESOR = 1 ½"



PLACAS INFERIORES
C15BFI1
UDS. = 1
ESPESOR = 1 ½"

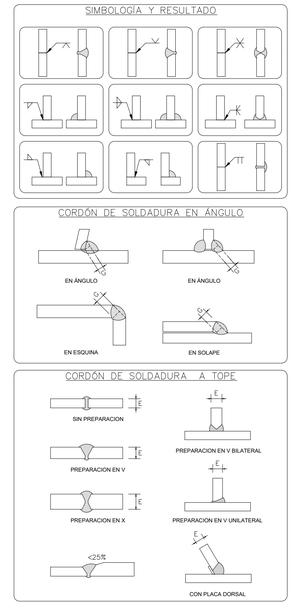


PLACAS SUPERIORES
C15BFS1
UDS. = 1
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C15BFR1
UDS. = 1
ESPESOR = 1 ½"

COLUMNA 15
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 15
UNIDADES = 1 COLUMNA

– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE LA COLUMNA 15

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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SECRETARIO DE OBRAS Y SERVICIOS
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0495

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 15. DESPIECE (II)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

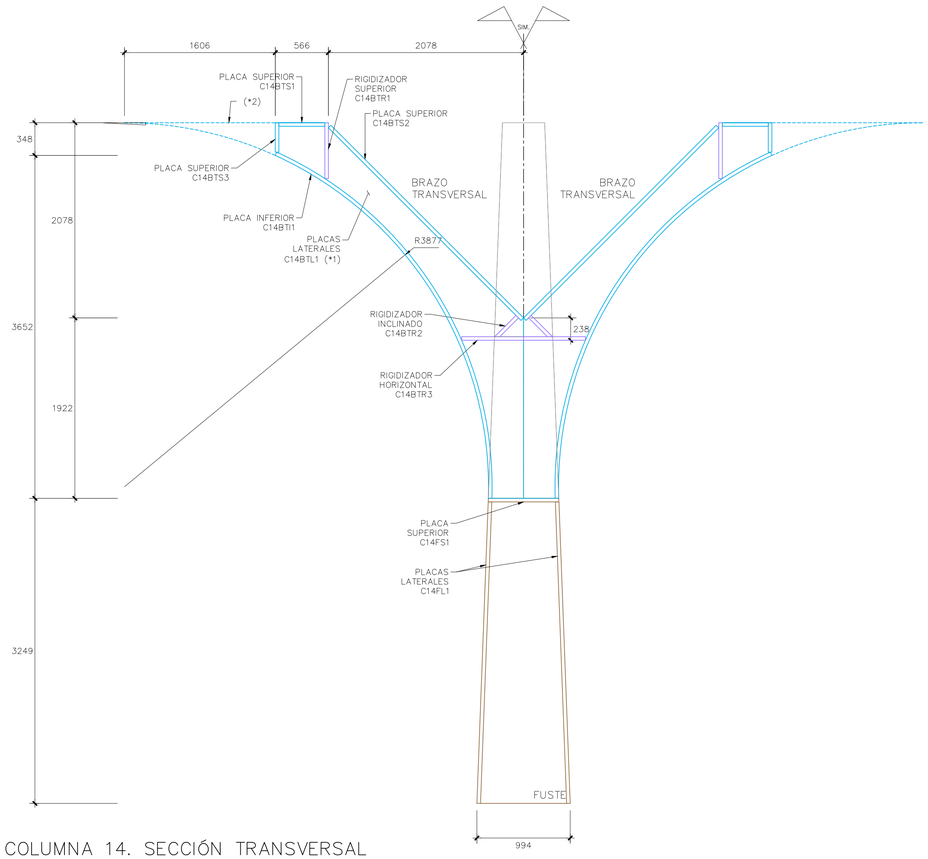
PLANO No. **DGOT-20-EST-III-0055-00256-P-00**

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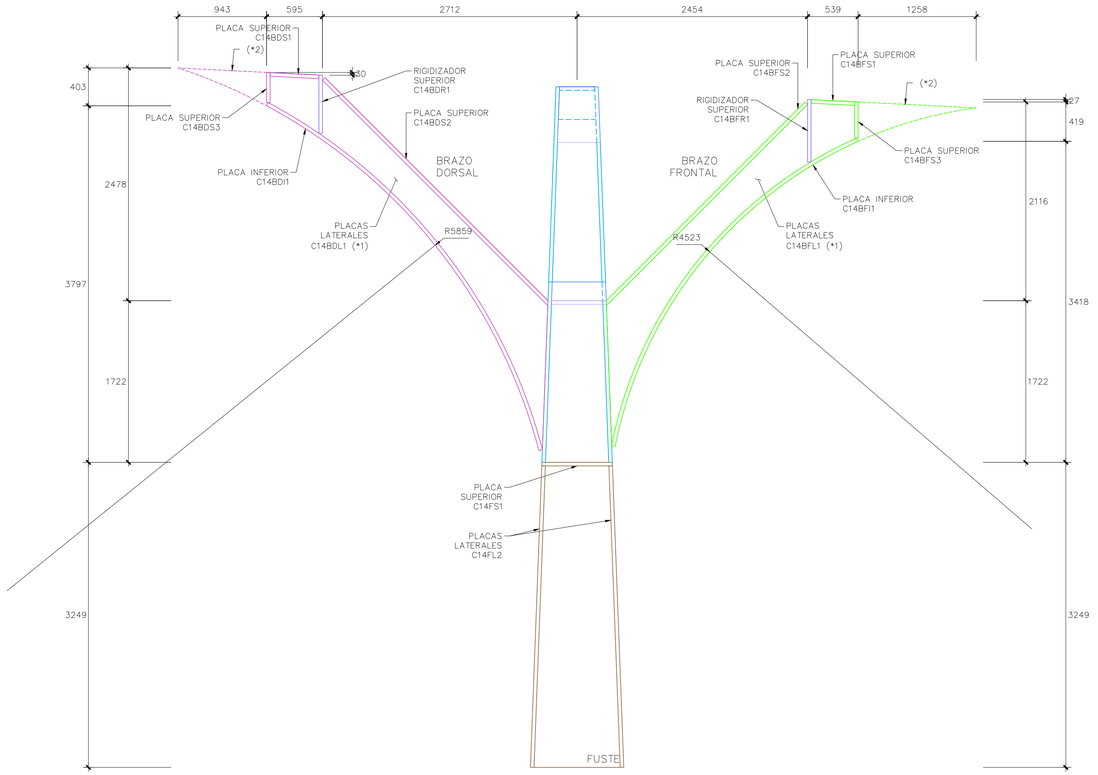
CO.DE.AC.	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

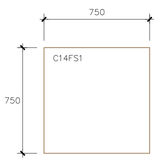
DGOT-20-EST-III-0055-00256-P-00



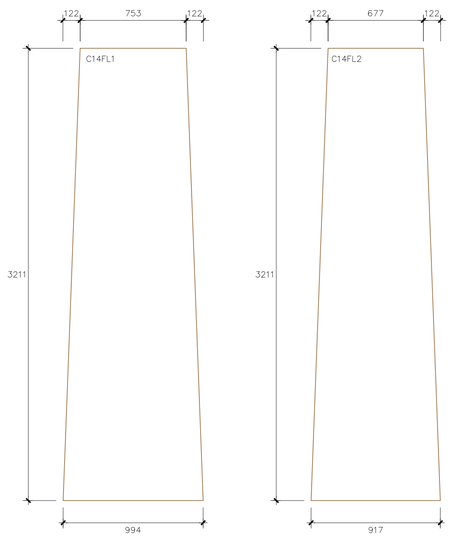
COLUMNA 14. SECCIÓN TRANSVERSAL
ESCALA 1:30



COLUMNA 14. SECCIÓN LONGITUDINAL
(PDTE. DE CAJÓN= 5%)
ESCALA 1:30



PLACA SUPERIOR
C14FS1
UDS. = 2
ESPESOR = 1 ½"

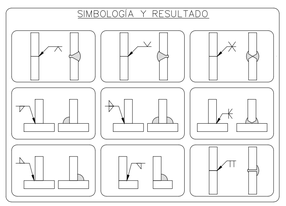


PLACAS
LATERALES C14FL1

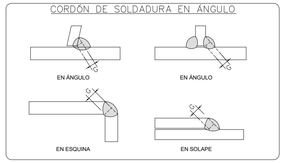
PLACAS
LATERALES C14FL2

COLUMNA 14
DESPIECE DE FUSTE
ESCALA 1:20

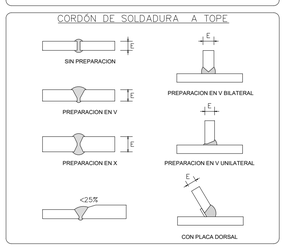
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 14

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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ING. ARQ. EDMUNDO REYES MADRID
DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0005

APROBÓ:
M. I. DANIEL PÉREZ BELLO

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 14. VISTAS

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

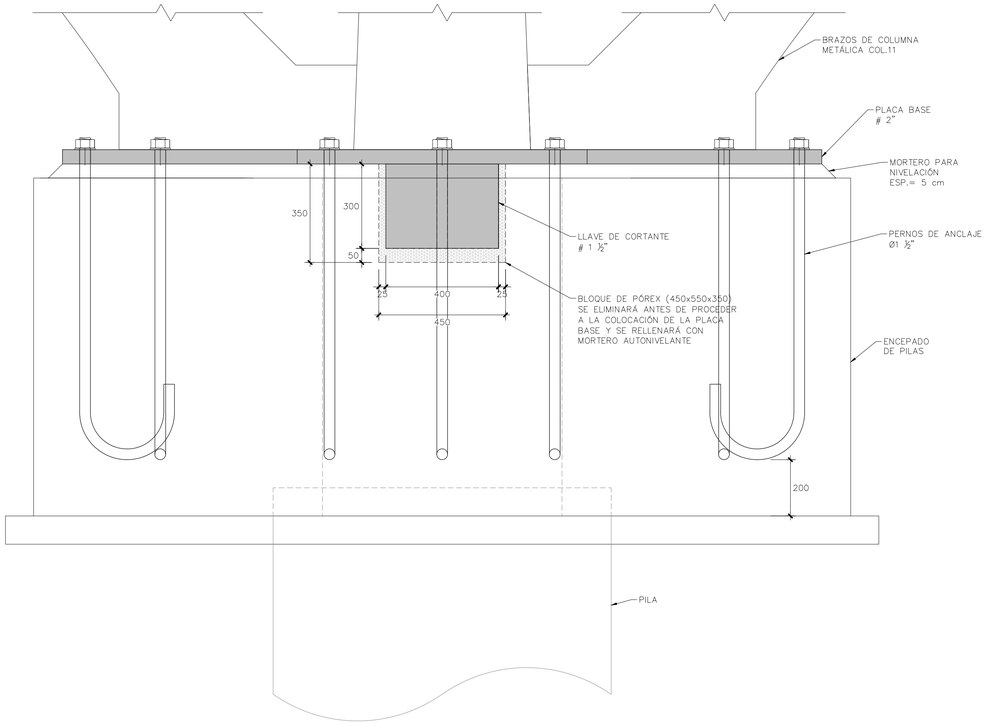
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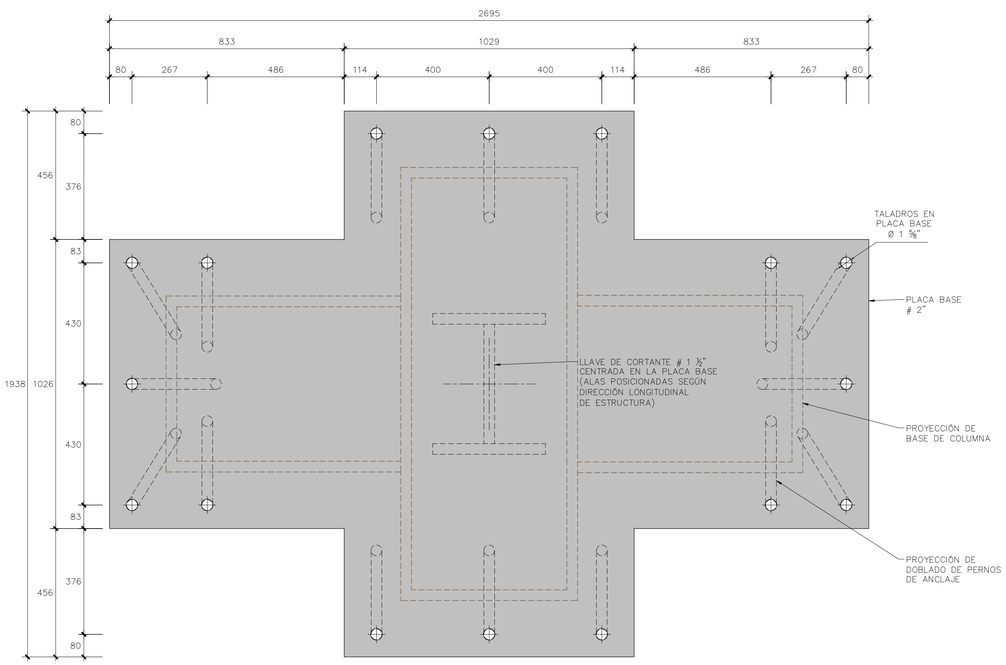
CRITERIO	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD. 1:30
FECHA: JULIO 2021
ESC.
ACOT. METROS

DGOT-20-EST-III-0050-00251-P-00

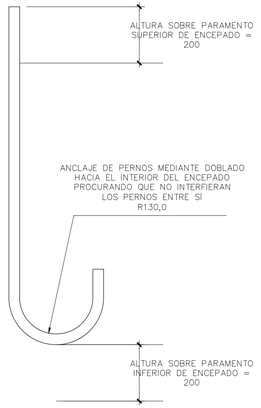


ALZADO
VISTA SEGÚN DIRECCIÓN LONGITUDINAL DE ESTRUCTURA

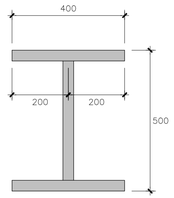


PLANTA
LA PLACA DE ANCLAJE SE SITÚA CENTRADA EN PLANTA SOBRE EL ENCEPADO

PLACAS DE ANCLAJE EN CIMENTACIÓN DE COLUMNA 11
ESCALA 1:10



PERNOS DE ANCLAJE Ø1 ½"
16 UNIDADES POR PLACA



LLAVE DE CORTANTE # 1 ½"

PLACAS DE ANCLAJE= 2 UDs. POR COLUMNA

MATERIALES DE ELEMENTOS DE PLACAS DE ANCLAJE

- PLACAS ACERO A709 GR.50
- PERNOS DE ANCLAJE ACERO A490

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRIDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

COLUMNAS METÁLICAS
PLACAS DE ANCLAJE A CIMENTACIONES (VI)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

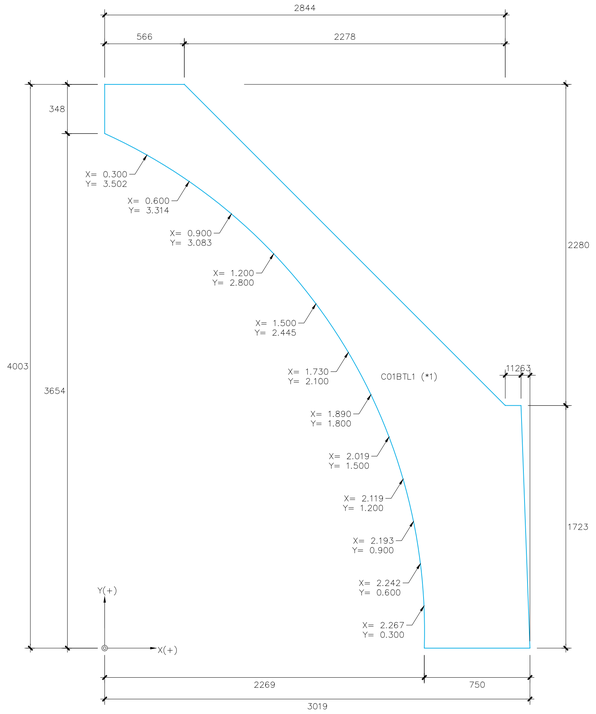
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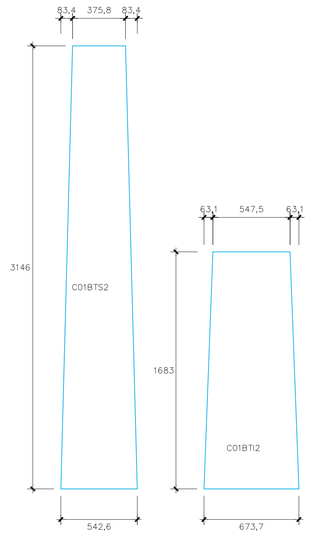
FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:10
	PROYECTO	M.I. INCIENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT: METROS

DIBUJO

DGOT-20-EST-III-0023-00224-P-00

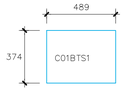


PLACAS
LATERALES
C01BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

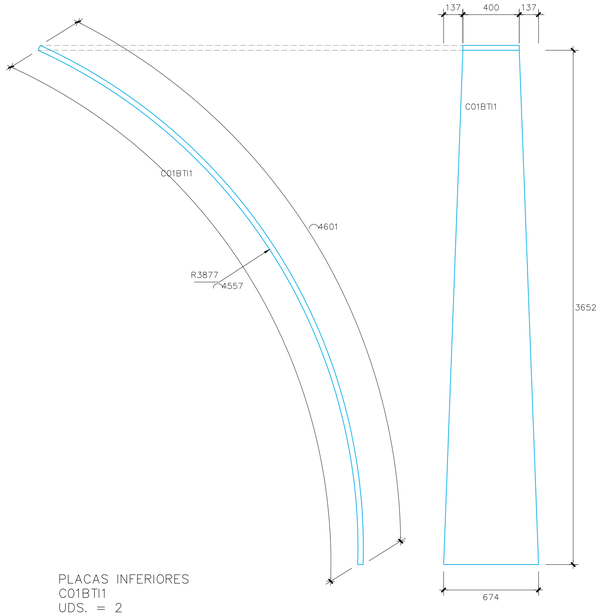


PLACAS SUPERIORES
C01BTS2
UDS. = 2
ESPESOR = 1 ½"

PLACA INFERIOR
C01BTI2
UDS. = 2
ESPESOR = 1 ½"



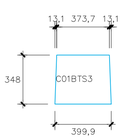
PLACAS SUPERIORES
C01BTS1
UDS. = 2
ESPESOR = 1 ½"



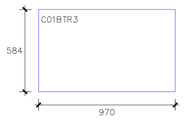
PLACAS INFERIORES
C01BTI1
UDS. = 2
ESPESOR = 1 ½"

PERFIL

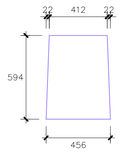
VISTA EN ALZADO



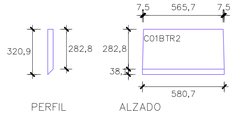
PLACAS SUPERIORES
C01BTS3
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C01BTR3
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C01BTR1
UDS. = 4
ESPESOR = 1 ½"

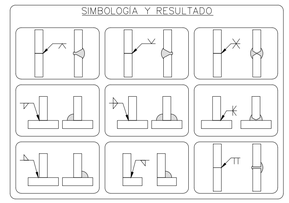


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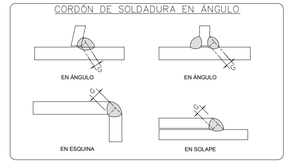
RIGIDIZADORES
C01BTR2
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 1
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

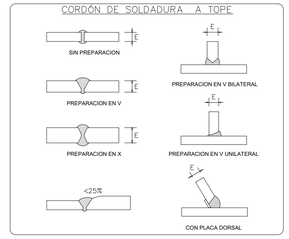
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 1

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1466

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CVE 5466

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 1. DESPIECE (I)

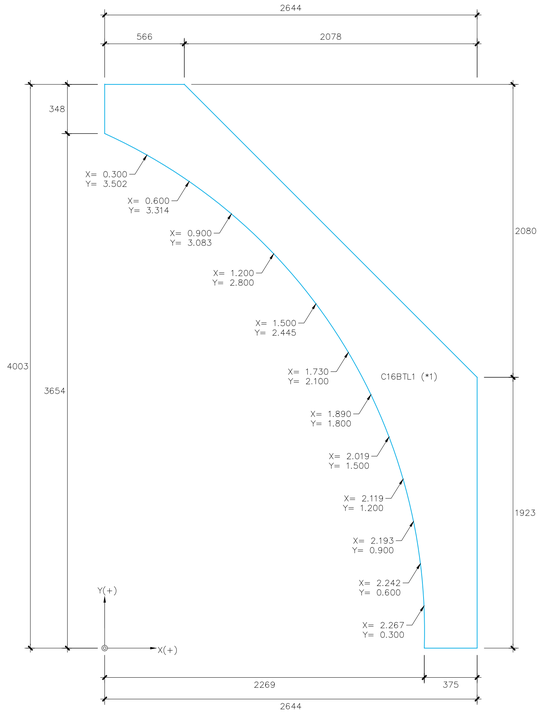
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0025-00226-P-00

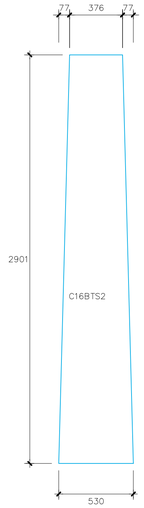
ESCALA GRÁFICA: 0.2 0.6 1

FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
	PROYECTO ESTRUCTURA	M.I. INOCENCIO MALDONADO TORRES		
	ARQUITECTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
				ACOT.: METROS

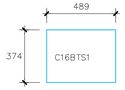
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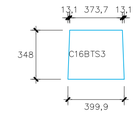
PLACAS
LATERALES
C16BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



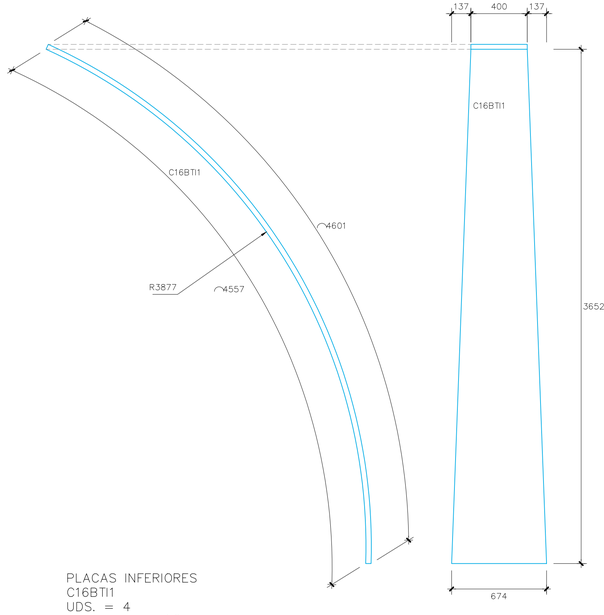
PLACAS SUPERIORES
C16BTS2
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C16BTS1
UDS. = 4
ESPESOR = 1 ½"

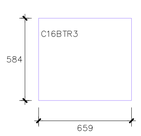


PLACAS SUPERIORES
C16BTS3
UDS. = 4
ESPESOR = 1 ½"

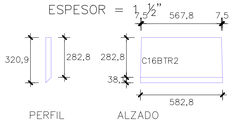


PLACAS INFERIORES
C16BTI1
UDS. = 4
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO

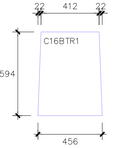


RIGIDIZADORES
C16BTR3
UDS. = 4
ESPESOR = 1 ½"



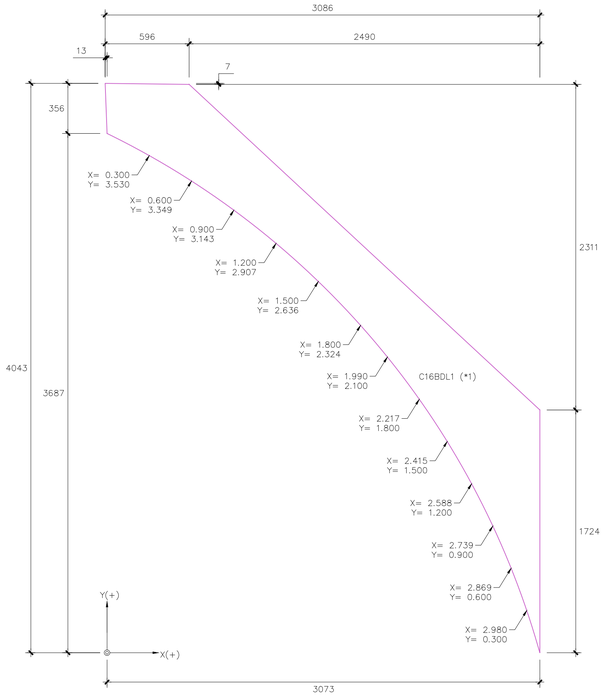
PERFIL ALZADO

RIGIDIZADORES
C16BTR2
UDS. = 4
ESPESOR = 1 ½"

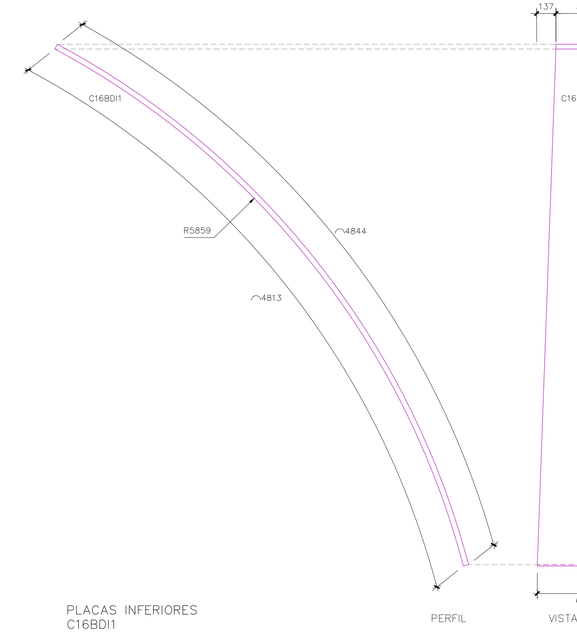


RIGIDIZADORES
C16BTR1
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 16
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20



PLACAS
LATERALES
C16BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



PLACAS INFERIORES
C16BDI1
UDS. = 2
ESPESOR = 1 ½"

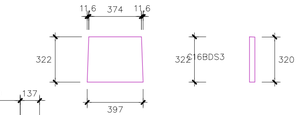
PERFIL VISTA EN ALZADO

COLUMNA 16
DESPIECE DE BRAZO DORSAL
ESCALA 1:20



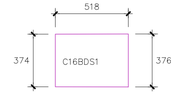
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C16BDS2
UDS. = 2
ESPESOR = 1 ½"

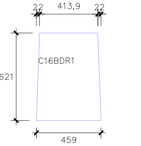


VISTA EN ALZADO PERFIL

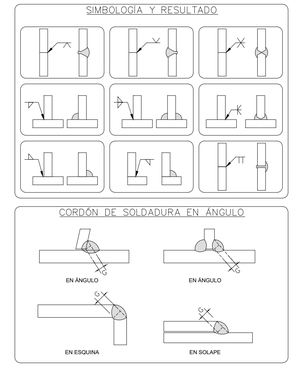
PLACAS SUPERIORES
C16BDS3
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C16BDS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C16BDR1
UDS. = 2
ESPESOR = 1 ½"



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 16

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1496

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-1496

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 16, DESPIECE (I)

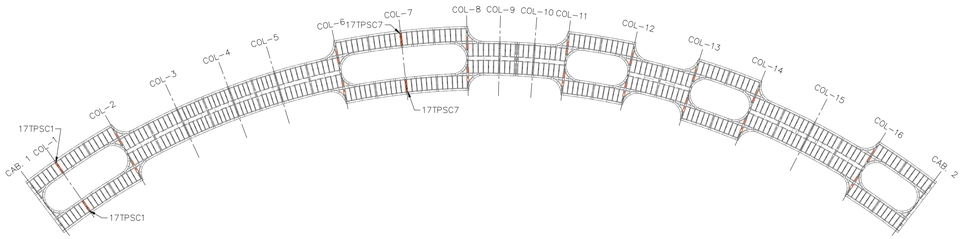
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0057-00258-P-00

ESCALA GRÁFICA: 0.2 0.6 1

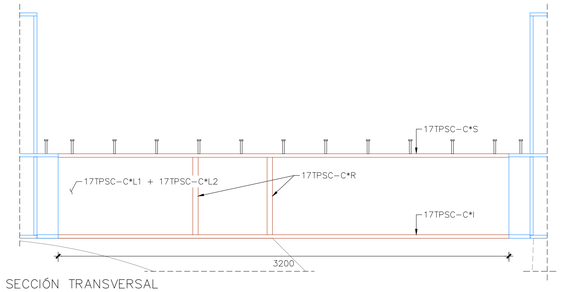
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

DGOT-20-EST-III-0057-00258-P-00



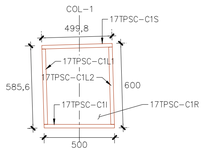
TRAVIESAS PRINCIPALES SOBRE COLUMNA. PLANTA GENERAL

ESCALA 1:500



SECCIÓN TRANSVERSAL

TRAVIESA 17TPSC-C1



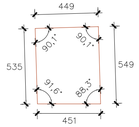
SECCIÓN LONGITUDIAL



PLACA 17TPSC-C1I
UDS.= 2
ESPESOR= 1"



PLACA 17TPSC-C1S
UDS.= 2
ESPESOR= 1"



PLACA 17TPSC-C1R
UDS.= 4
ESPESOR= 1½"

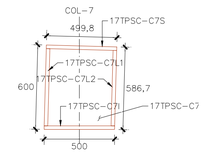


PLACA 17TPSC-C1L1
UDS.= 2
ESPESOR= 1"

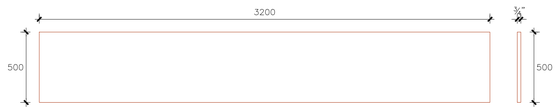


PLACA 17TPSC-C1L2
UDS.= 2
ESPESOR= 1"

TRAVIESA 17TPSC-C7



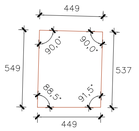
SECCIÓN LONGITUDIAL



PLACA 17TPSC-C7I
UDS.= 2
ESPESOR= 1"



PLACA 17TPSC-C7S
UDS.= 2
ESPESOR= 1"



PLACA 17TPSC-C7R
UDS.= 4
ESPESOR= 1½"



PLACA 17TPSC-C7L1
UDS.= 2
ESPESOR= 1"

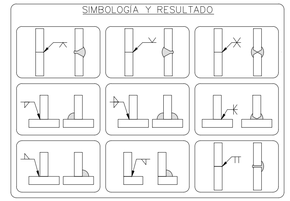


PLACA 17TPSC-C7L2
UDS.= 2
ESPESOR= 1"

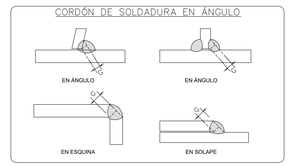
ANCHO TABLERO= 17,00m. TRAVIESA PRINCIPAL SOBRE COLUMNA

ESCALA 1:20

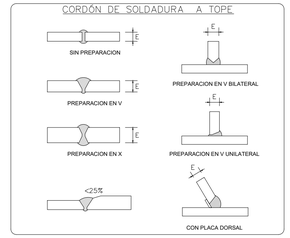
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SANCHEZ

FIEDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR UNICO
FIEDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CRO-1450

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE-5650

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJO:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA
TRAVIESAS PRINCIPALES (II)

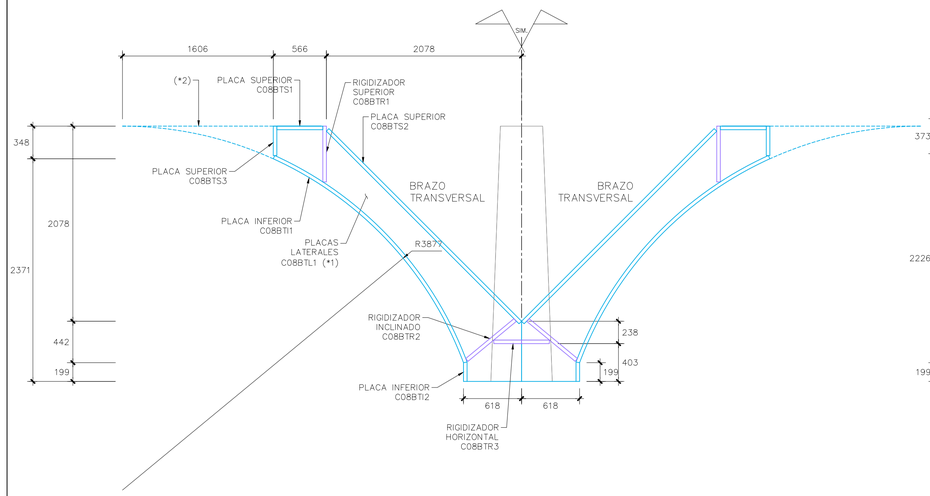
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: DGOT-20-EST-III-0082-00283-P-00

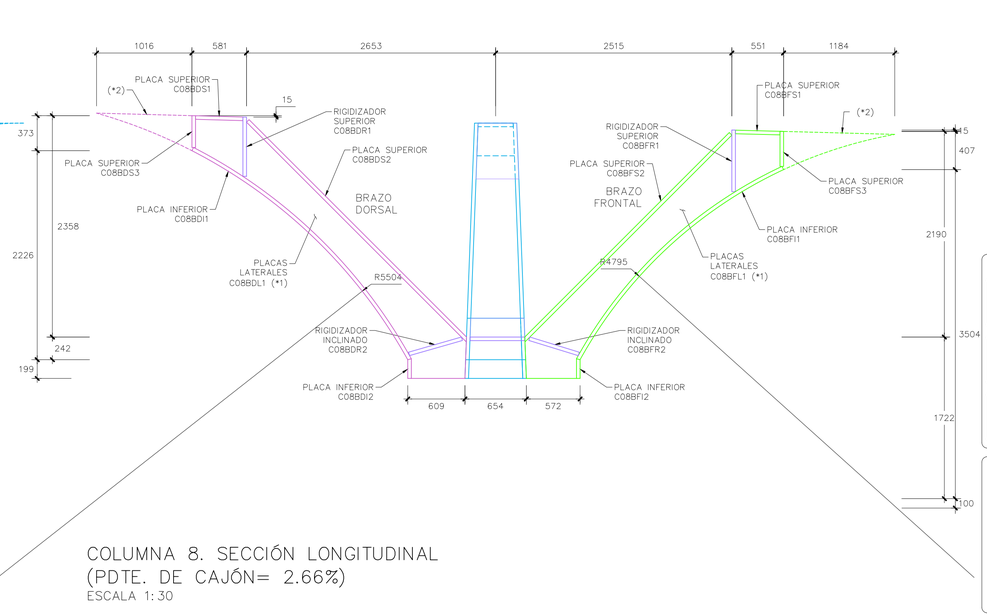
ESCALA GRÁFICA: 2 0 6 6 1 0

ESCALA	FECHA	DISEÑO	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARQG. RAMÓN CAPISTRÁN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ		DIBUJ.
					ACOT. METROS

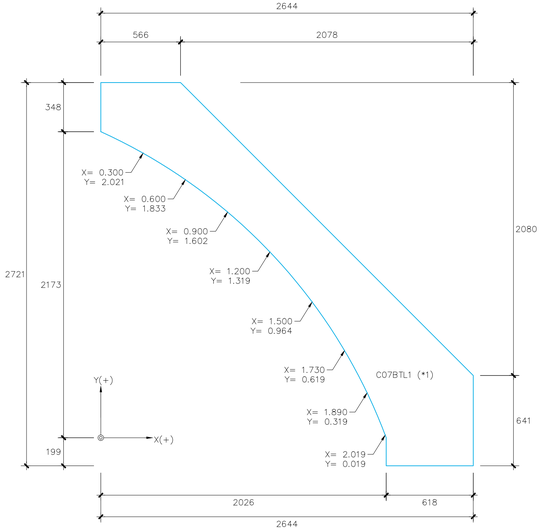
DGOT-20-EST-III-0082-00283-P-00



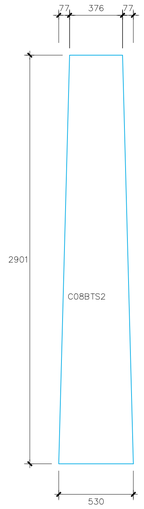
COLUMNA 8. SECCIÓN TRANSVERSAL
ESCALA 1:30



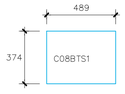
COLUMNA 8. SECCIÓN LONGITUDINAL
(PDTE. DE CAJÓN= 2.66%)
ESCALA 1:30



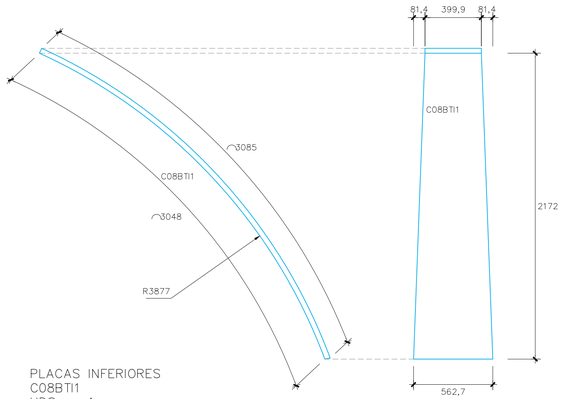
PLACAS LATERALES
C08BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



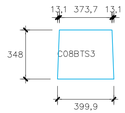
PLACAS SUPERIORES
C08BTS2
UDS. = 4
ESPESOR = 1 ½"



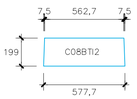
PLACAS SUPERIORES
C08BTS1
UDS. = 4
ESPESOR = 1 ½"



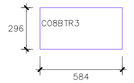
PLACAS INFERIORES
C08BTI1
UDS. = 4
ESPESOR = 1 ½"



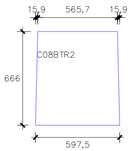
PLACAS SUPERIORES
C08BTS3
UDS. = 4
ESPESOR = 1 ½"



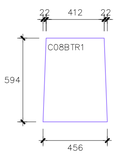
PLACAS INFERIORES
C08BTI2
UDS. = 4
ESPESOR = 1 ½"



RIGIDIZADORES
C08BTR3
UDS. = 4
ESPESOR = 1 ½"

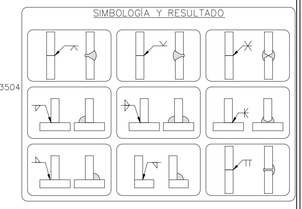


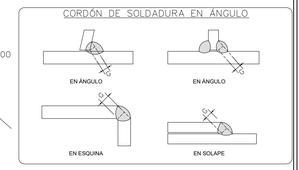
RIGIDIZADORES
C08BTR2
UDS. = 4
ESPESOR = 1 ½"

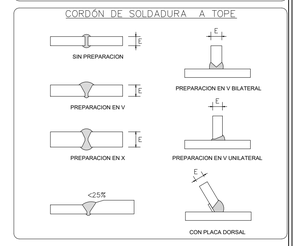


RIGIDIZADORES
C08BTR1
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 8
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20







ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
PREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0695

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 8. VISTAS Y DESPIECE (I)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0038-00239-P-00

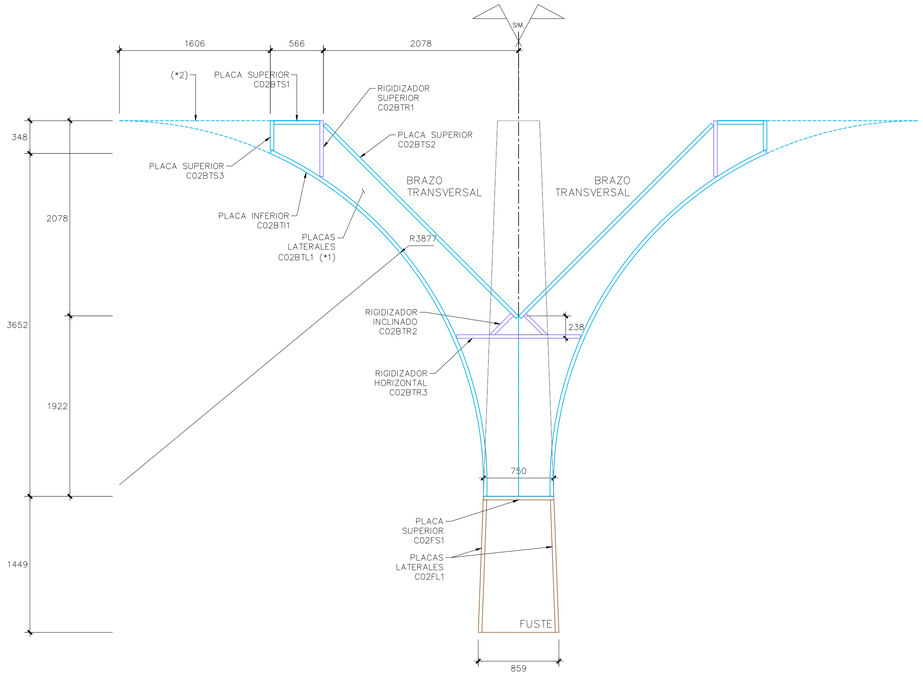
ESCALA GRÁFICA: 0 0.3 0.9 1.5 3

FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

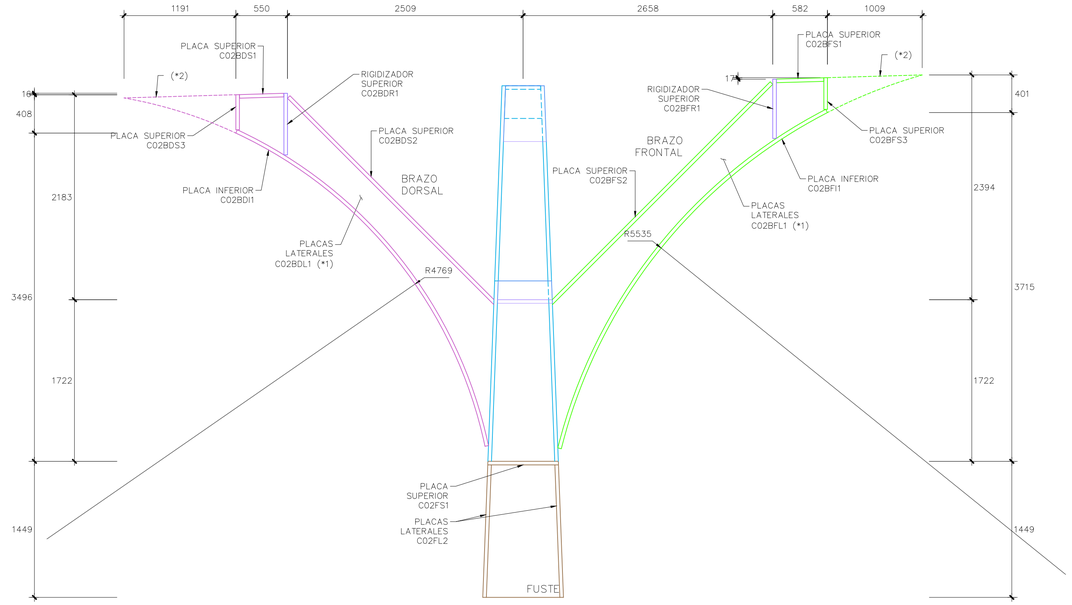
DISEÑÓ

MOD: 1:30
FECHA: JULIO 2021
ESC:
ACOT: METROS

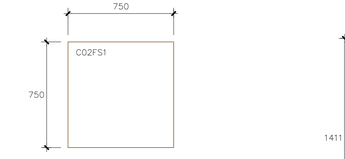
DGOT-20-EST-III-0038-00239-P-00



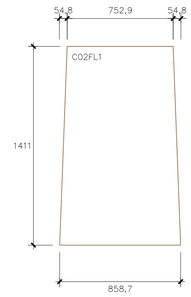
COLUMNA 2. SECCIÓN TRANSVERSAL
ESCALA 1:30



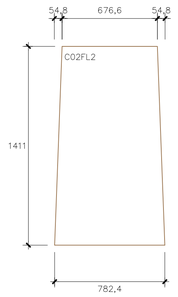
COLUMNA 2. SECCIÓN LONGITUDINAL (PDTE. DE CAJÓN= 2.88%)
ESCALA 1:30



PLACA SUPERIOR
C02FS1
UDS. = 2
ESPESOR = 1 ½"

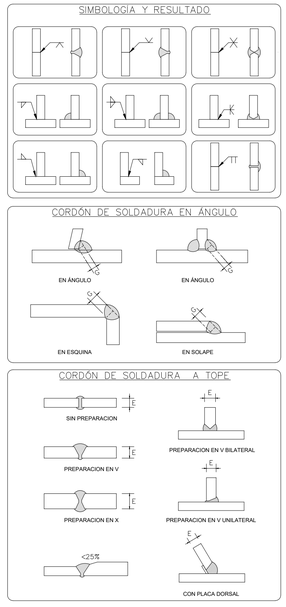


PLACAS
LATERALES C02FL1
UDS. = 4
ESPESOR = 1 ½"



PLACAS
LATERALES C02FL2
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 2
DESPIECE DE FUSTE
ESCALA 1:20



ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS COLUMNA 2

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
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PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 2. VISTAS

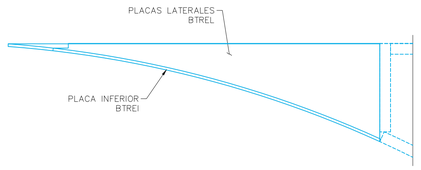
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

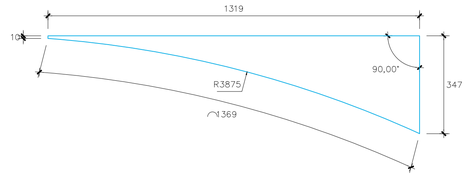
PLANO No.: **DGOT-20-EST-III-0027-00228-P-00**

ESCALA GRÁFICA: 0.3 0.9 1.5

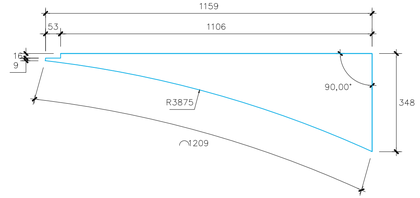
SECTOR	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:30
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN		ESC:
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ACOT: METROS

DGOT-20-EST-III-0027-00228-P-00

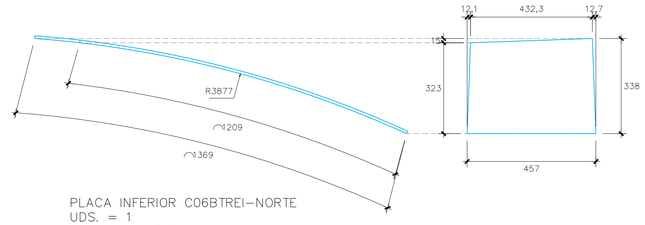




PLACAS LATERALES C06BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

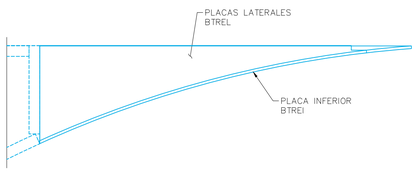


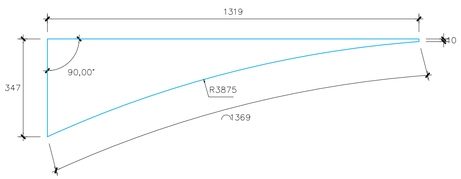
PLACAS LATERALES C06BTREL–NORTE–FRONTAL
UDS. = 1
ESPESOR = ⅜"



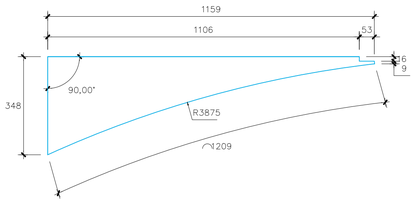
PLACA INFERIOR C06BTREI–NORTE
UDS. = 1
ESPESOR = ⅜"

COLUMNA 6 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10

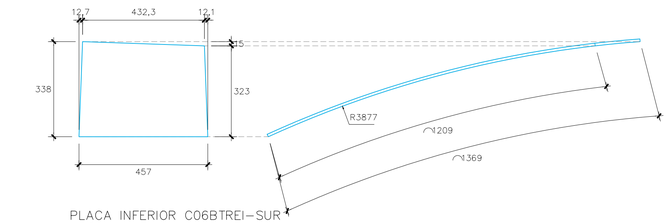




PLACAS LATERALES C06BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = ⅜"

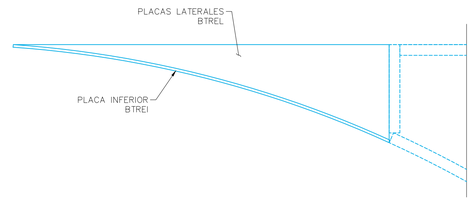


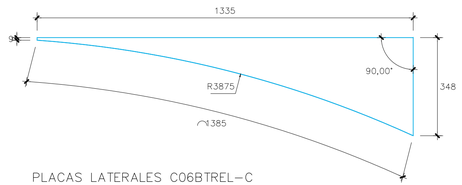
PLACAS LATERALES C06BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = ⅜"



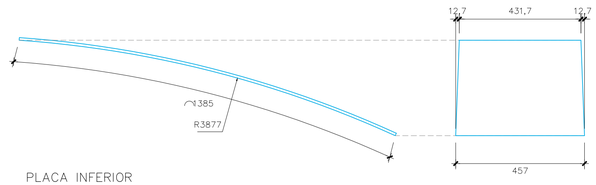
PLACA INFERIOR C06BTREI–SUR
UDS. = 1
ESPESOR = ⅜"

COLUMNA 6 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10



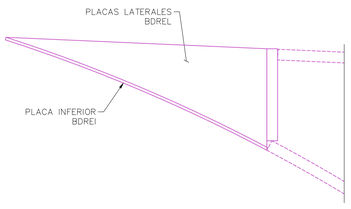


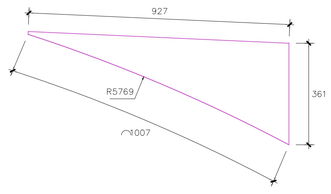
PLACAS LATERALES C06BTREL–C
UDS. = 4
ESPESOR = ⅜"



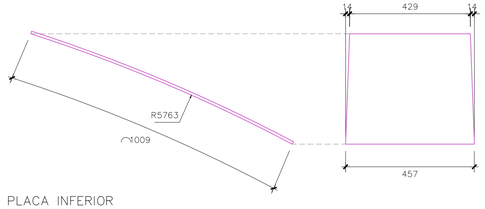
PLACA INFERIOR
C06BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 6
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



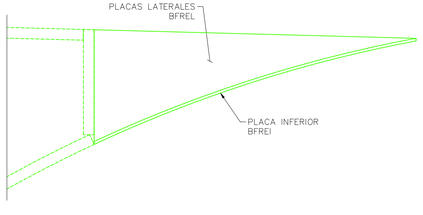


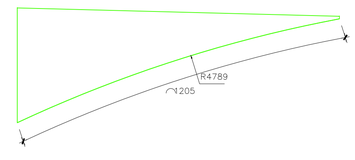
PLACAS LATERALES
C06BDREL
UDS. = 4
ESPESOR = ⅜"



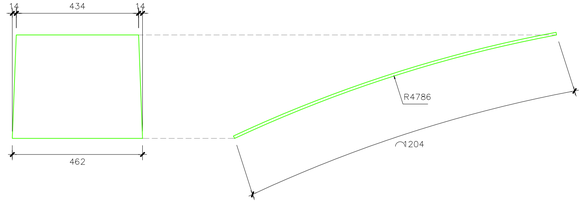
PLACA INFERIOR
C06BDREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 6
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10



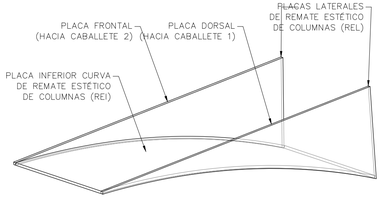


PLACAS LATERALES
C06BFREL
UDS. = 4
ESPESOR = ⅜"



PLACA INFERIOR
C06BFREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 6
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

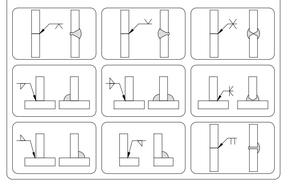


REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

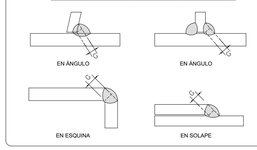
REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

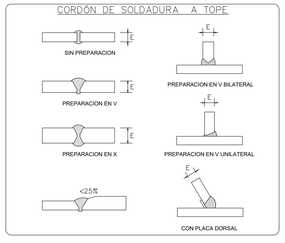
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

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ING. ARQ. EDMUNDO REYES MADRID
DRO-1488

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0455

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
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TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTETICOS SUPERIORES
COLUMNA 6. DESPIECE

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

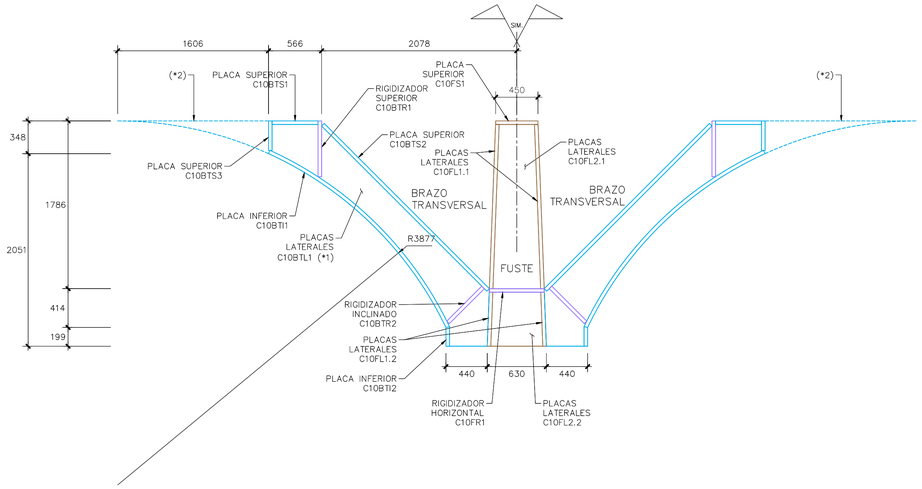
PLANO No.
DGOT-20-EST-III-0062-00263-P-00

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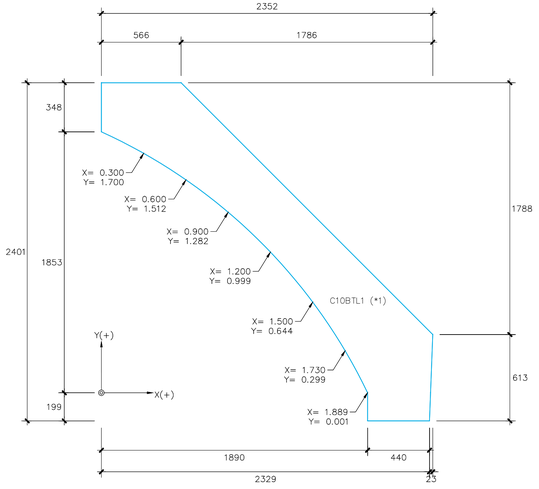
DETALLE	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ	

MOD: 1:10
FECHA: JULIO 2021
ESC:
ACOT: METROS

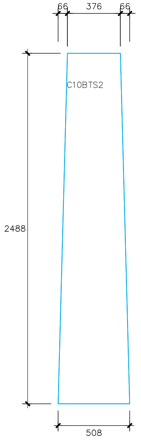
DGOT-20-EST-III-0062-00263-P-00



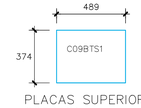
COLUMNA 9. SECCIÓN TRANSVERSAL
ESCALA 1:30



PLACAS LATERALES
C09BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

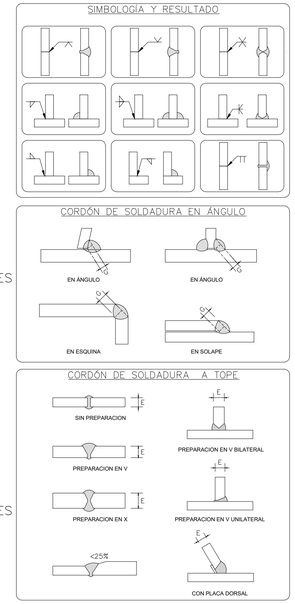


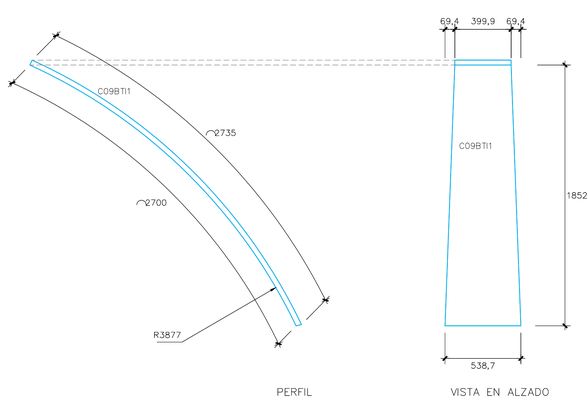
PLACAS SUPERIORES
C09BTS2
UDS. = 2
ESPESOR = 1 ½"



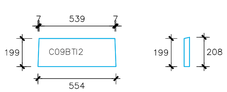
PLACAS SUPERIORES
C09BTS1
UDS. = 2
ESPESOR = 1 ½"

PLACAS SUPERIORES
C09BTS3
UDS. = 2
ESPESOR = 1 ½"

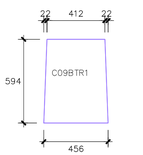




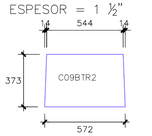
PLACAS INFERIORES
C09BTI1
UDS. = 2
ESPESOR = 1 ½"



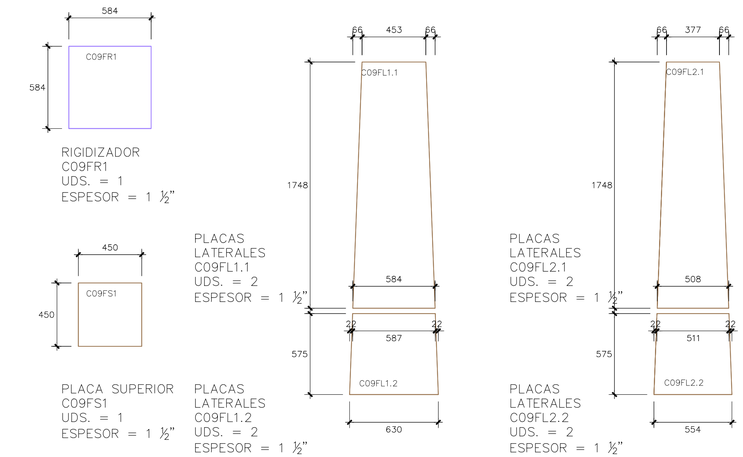
PLACAS INFERIORES
C09BTI2
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C09BTR1
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C09BTR2
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADOR
C09FR1
UDS. = 1
ESPESOR = 1 ½"

PLACAS LATERALES
C09FL1.1
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C09FL2.1
UDS. = 2
ESPESOR = 1 ½"

PLACA SUPERIOR
C09FS1
UDS. = 1
ESPESOR = 1 ½"

PLACAS LATERALES
C09FL1.2
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C09FL2.2
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 9
DESPIECE DE FUSTE
ESCALA 1:20

COLUMNA 9
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS
BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO
SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 9
UNIDADES = 1 COLUMNA

– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE UNA COLUMNA.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO

APROBÓ: M. I. DANIEL PÉREZ BELLO
REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA
PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA
DIBUJÓ: M.B.
OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 9. VISTAS Y DESPIECE

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

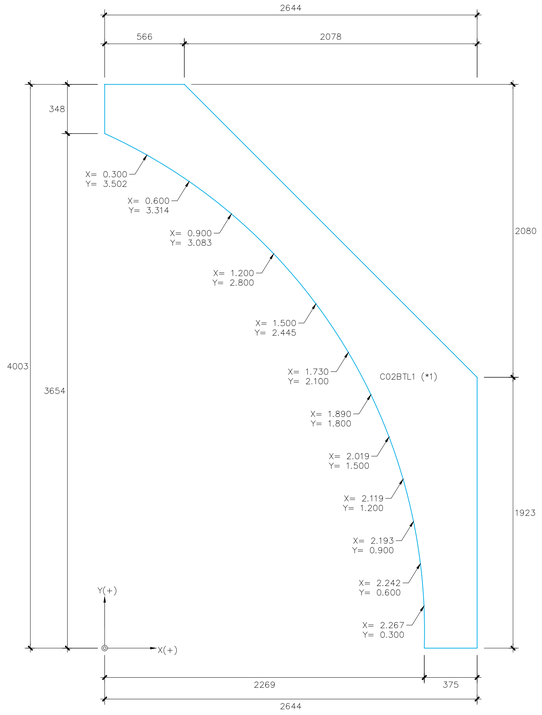
PLANO No.: DGOT-20-EST-III-0040-00241-P-00

ESCALA GRÁFICA: 0 0.5 0.9 1.5 3

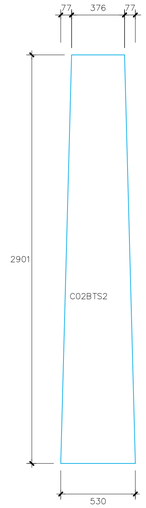
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. PROCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD. 1:30
FECHA: JULIO 2021
ESC:
ACOT. METROS

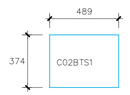
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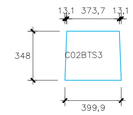
PLACAS
LATERALES
C02BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



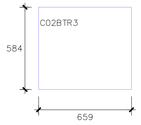
PLACAS SUPERIORES
C02BTS2
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C02BTS1
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C02BTS3
UDS. = 4
ESPESOR = 1 ½"

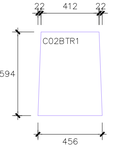


RIGIDIZADORES
C02BTR3
UDS. = 4
ESPESOR = 1 ½"

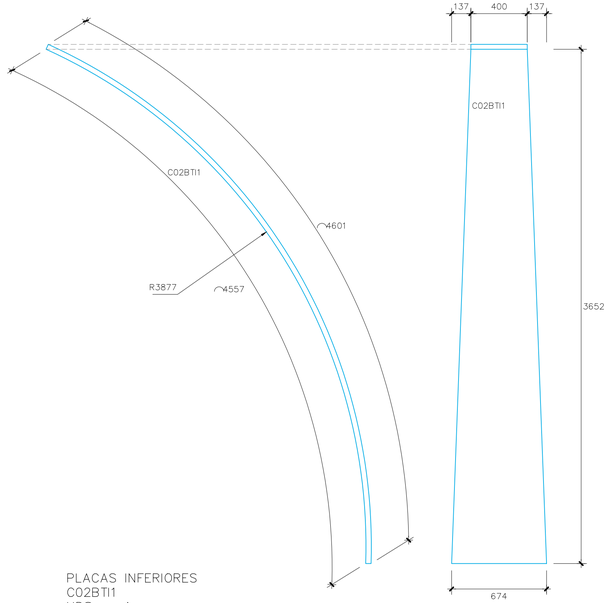


PERFIL ALZADO

RIGIDIZADORES
C02BTR2
UDS. = 4
ESPESOR = 1 ½"



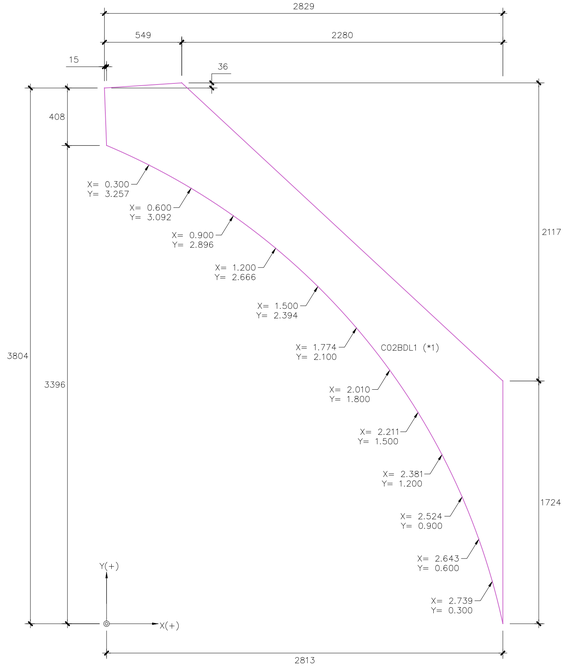
RIGIDIZADORES
C02BTR1
UDS. = 4
ESPESOR = 1 ½"



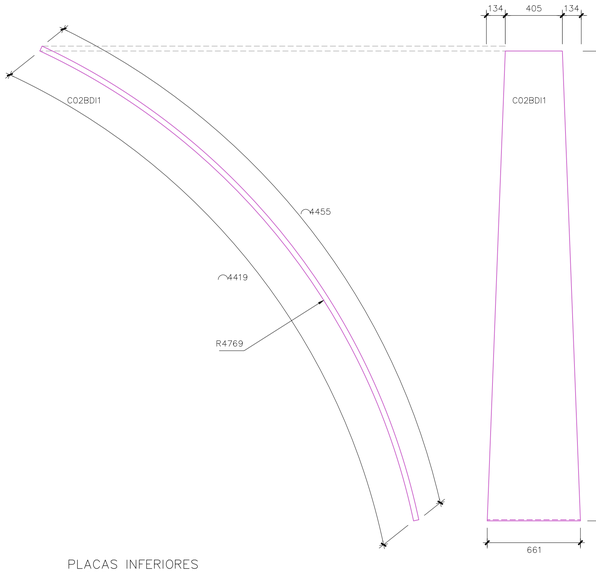
PLACAS INFERIORES
C02BTI1
UDS. = 4
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO

COLUMNA 2
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20



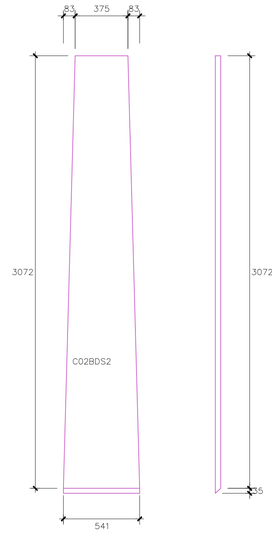
PLACAS
LATERALES
C02BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



PLACAS INFERIORES
C02BDI1
UDS. = 2
ESPESOR = 1 ½"

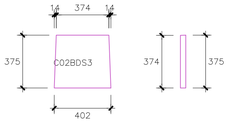
PERFIL VISTA EN ALZADO

COLUMNA 2
DESPIECE DE BRAZO DORSAL
ESCALA 1:20



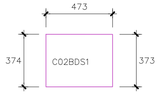
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C02BDS2
UDS. = 2
ESPESOR = 1 ½"

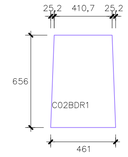


VISTA EN ALZADO PERFIL

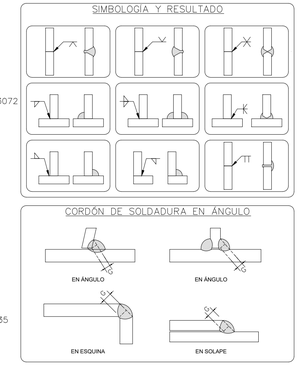
PLACAS SUPERIORES
C02BDS3
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C02BDS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C02BDR1
UDS. = 2
ESPESOR = 1 ½"



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS COLUMNA 2

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 2. DESPIECE (I)

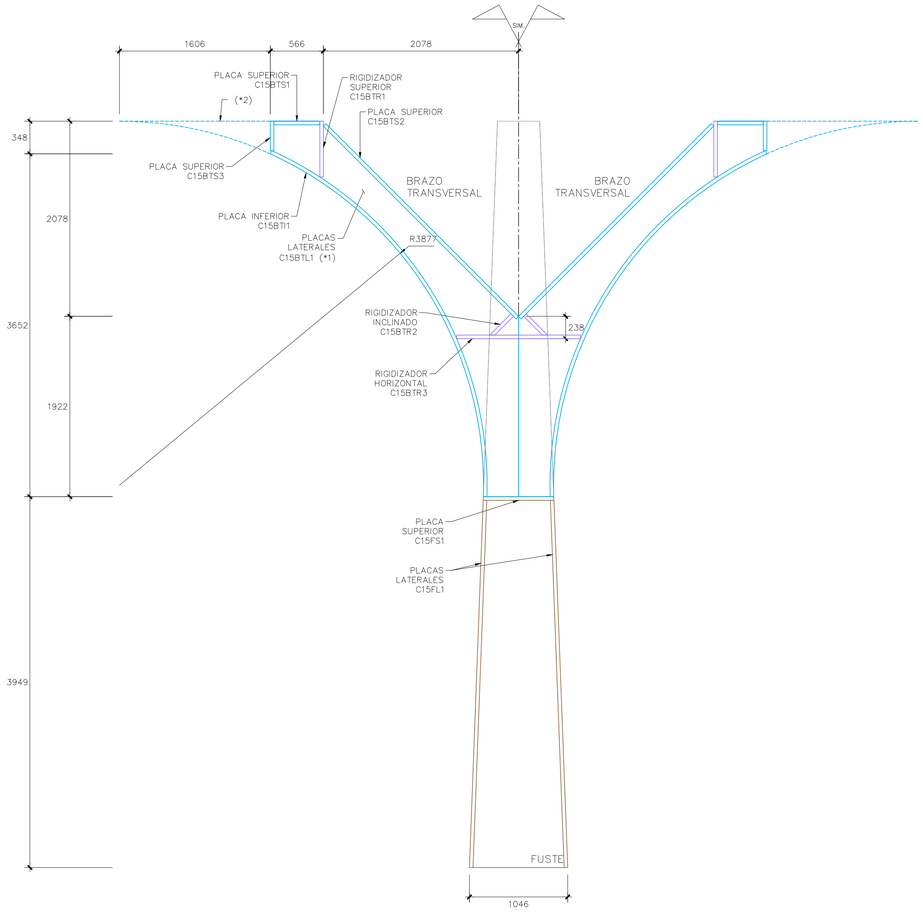
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0028-00229-P-00

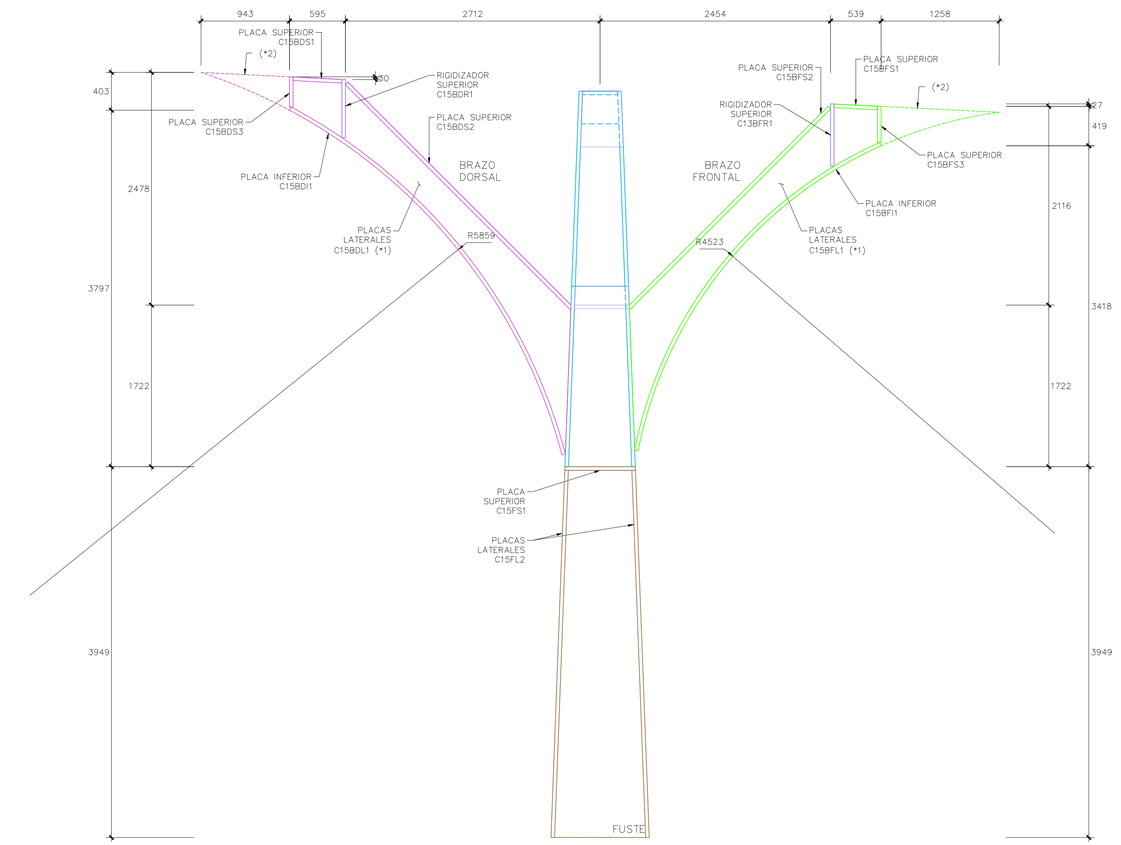
ESCALA GRÁFICA: 0.2 0.6 1

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

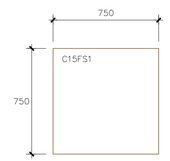
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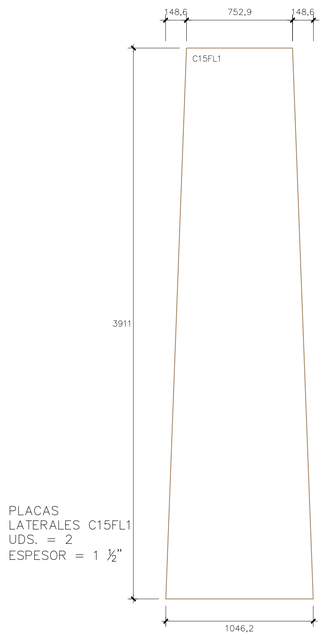
COLUMNA 15. SECCIÓN TRANSVERSAL
ESCALA 1:30



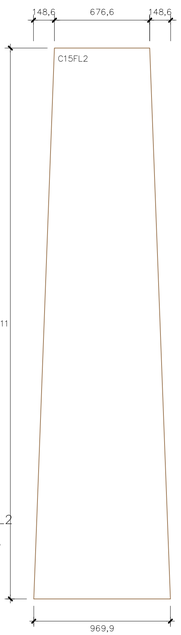
COLUMNA 15. SECCIÓN LONGITUDINAL (PDTE. DE CAJÓN= 5%)
ESCALA 1:30



PLACA SUPERIOR
C15FS1
UDS. = 1
ESPESOR = 1 ½"



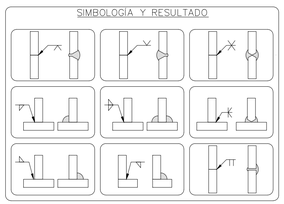
PLACAS
LATERALES C15FL1
UDS. = 2
ESPESOR = 1 ½"



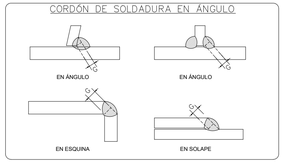
PLACAS
LATERALES C15FL2
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 15
DESPIECE DE FUSTE
ESCALA 1:20

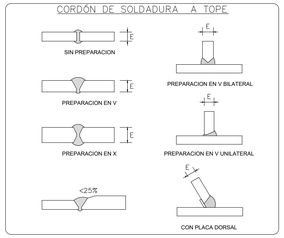
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 15
UNIDADES = 1 COLUMNA

- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE LA COLUMNA 15

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

GOBIERNO DE LA CIUDAD DE MÉXICO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A. DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MAIORO
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 15. VISTAS

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

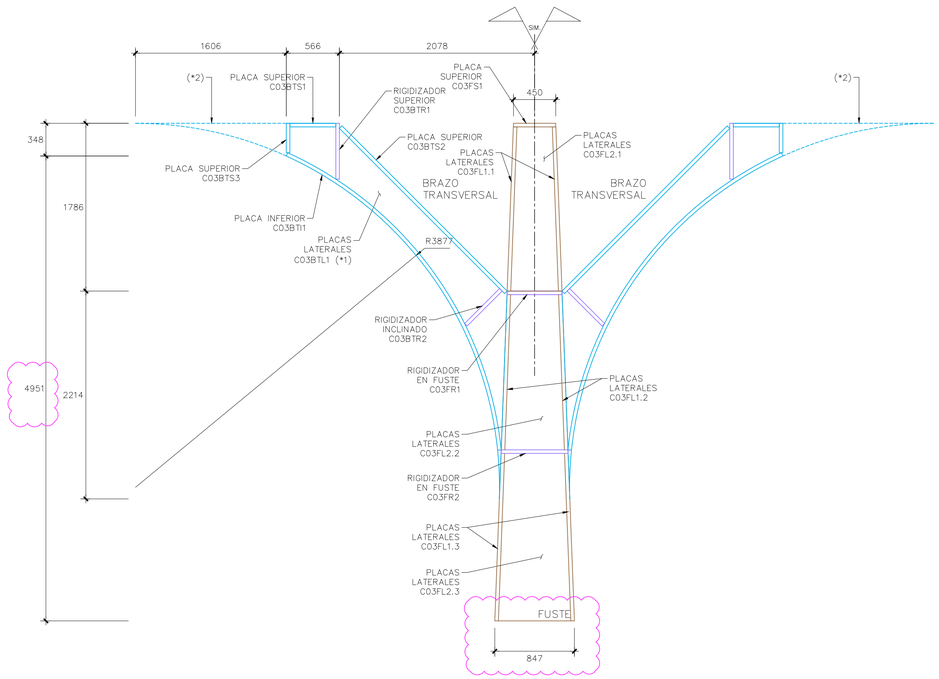
PLANO No.
DGOT-20-EST-III-0053-00254-P-00

ESCALA GRÁFICA
0 0.3 0.9 1.5

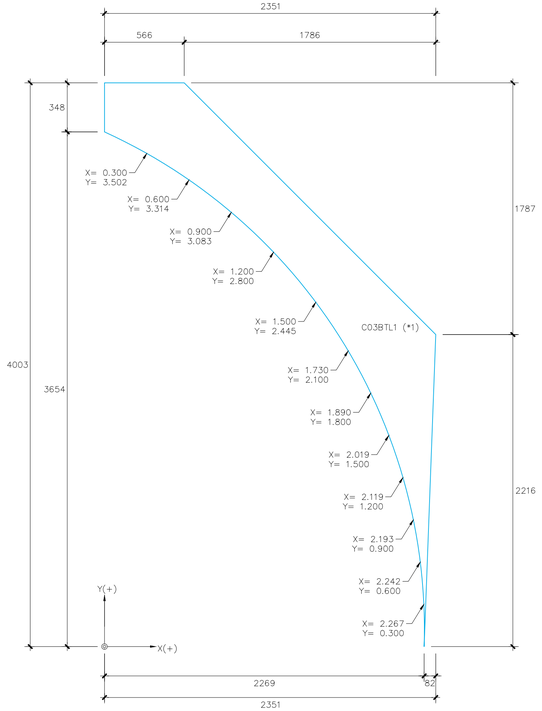
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD.: 1:30
FECHA: JULIO 2021
ESC.:
ACOT.: METROS

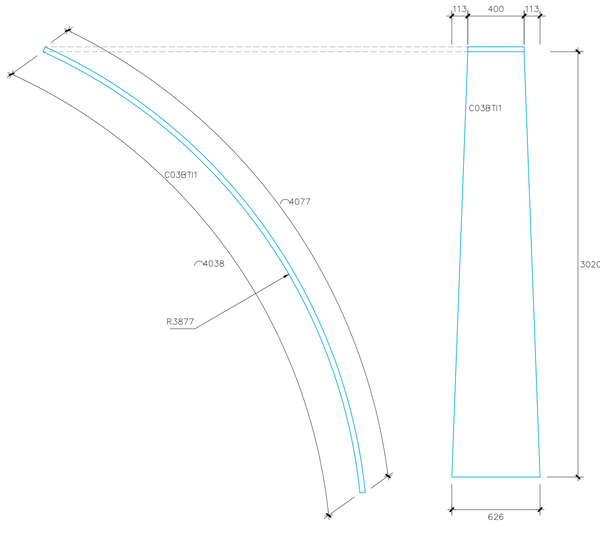
DGOT-20-EST-III-0053-00254-P-00



COLUMNA 3. SECCIÓN TRANSVERSAL
ESCALA 1:30

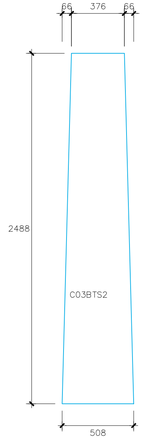


PLACAS LATERALES C03BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



PLACAS INFERIORES
C03BTI1
UDS. = 2
ESPESOR = 1 ½"

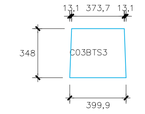
COLUMNA 3
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20



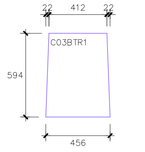
PLACAS SUPERIORES
C03BTS2
UDS. = 2
ESPESOR = 1 ½"



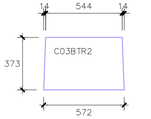
PLACAS SUPERIORES
C03BTS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C03BTS3
UDS. = 2
ESPESOR = 1 ½"

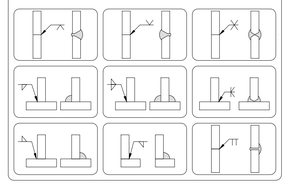


RIGIDIZADORES
C03BTR1
UDS. = 2
ESPESOR = 1 ½"

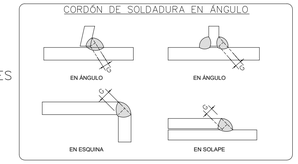


RIGIDIZADORES
C03BTR1
UDS. = 2
ESPESOR = 1 ½"

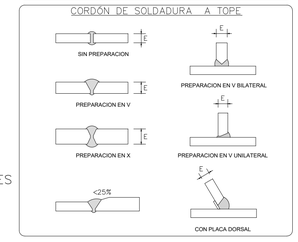
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

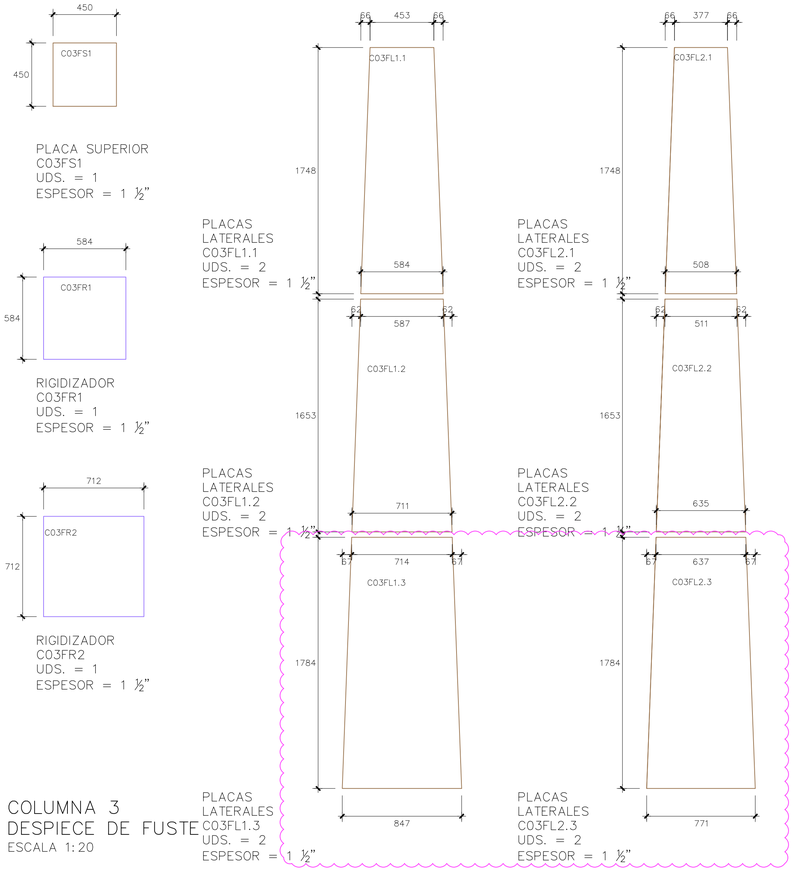
(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

NOTAS GENERALES

1 COLUMNA 3

– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE UNA COLUMNA.



PLACA SUPERIOR
C03FS1
UDS. = 1
ESPESOR = 1 ½"

RIGIDIZADOR
C03FR1
UDS. = 1
ESPESOR = 1 ½"

RIGIDIZADOR
C03FR2
UDS. = 1
ESPESOR = 1 ½"

PLACAS LATERALES
C03FL1.1
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C03FL1.2
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C03FL1.3
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C03FL2.1
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C03FL2.2
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C03FL2.3
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 3
DESPIECE DE FUSTE
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

PROYECTOS ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
PROYECTOS, INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE-0885

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 3. VISTAS Y DESPIECE

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

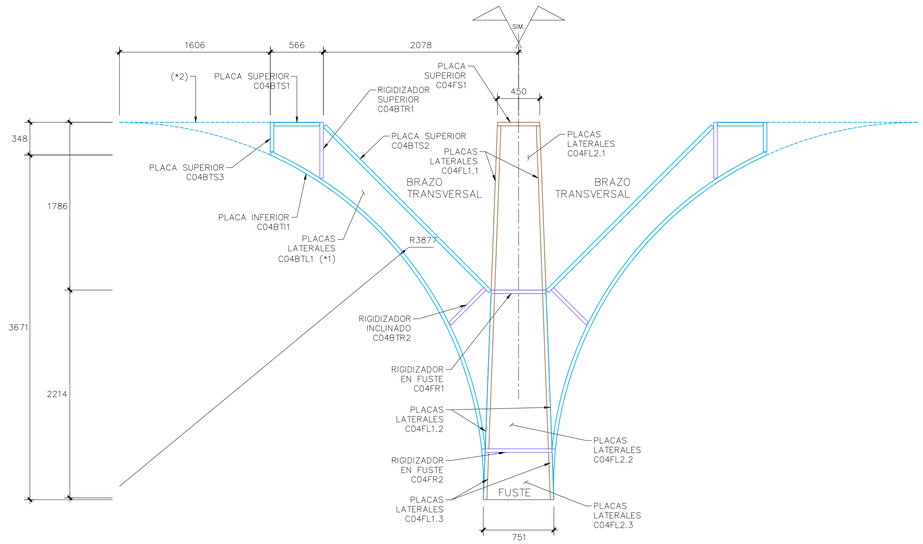
PLANO No.
DGOT-20-EST-III-0030-00231-P-00

ESCALA GRÁFICA 0 3 9 15 m

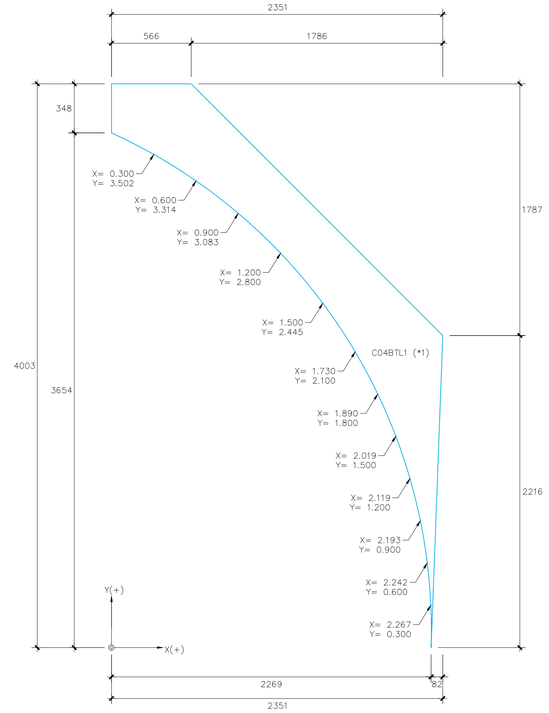
FECHA:	DEPTO	NOMBRE	FIRMA	MOD: 1:30
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ARQS. RAMÓN CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT: METROS

DIBUJO

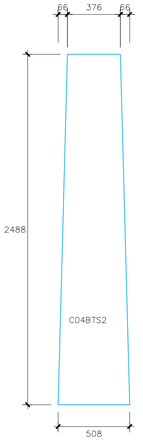
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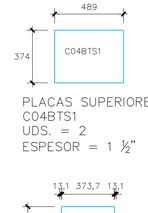
COLUMNA 4. SECCIÓN TRANSVERSAL
ESCALA 1:30



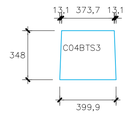
PLACAS LATERALES
C04BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



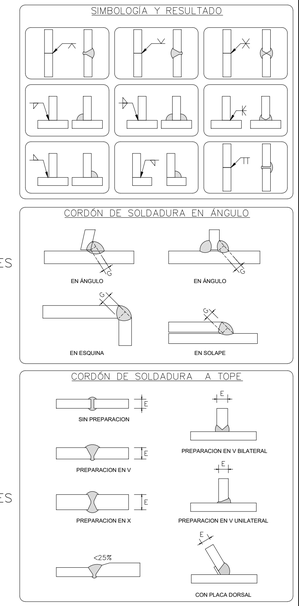
PLACAS SUPERIORES
C04BTS2
UDS. = 2
ESPESOR = 1 ½"

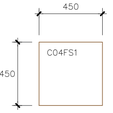


PLACAS SUPERIORES
C04BTS1
UDS. = 2
ESPESOR = 1 ½"

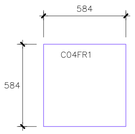


PLACAS SUPERIORES
C04BTS3
UDS. = 2
ESPESOR = 1 ½"

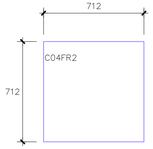




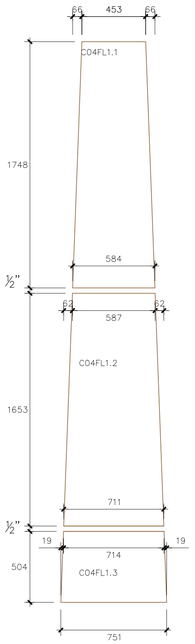
PLACA SUPERIOR
C04FS1
UDS. = 1
ESPESOR = 1 ½"



RIGIDIZADOR
C04FR1
UDS. = 1
ESPESOR = 1 ½"



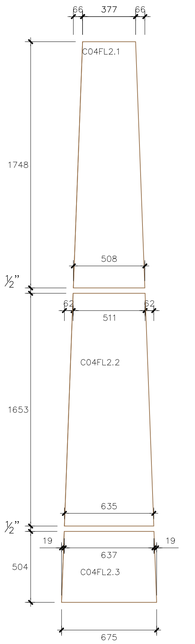
RIGIDIZADOR
C04FR2
UDS. = 1
ESPESOR = 1 ½"



PLACAS LATERALES
C04FL1.1
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C04FL1.2
UDS. = 2
ESPESOR = 1 ½"

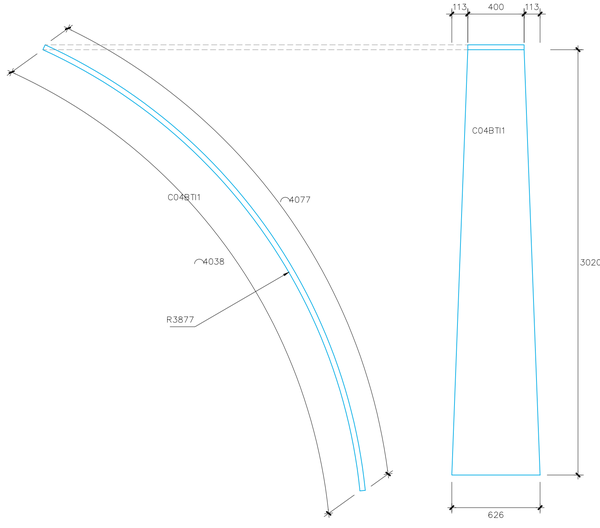
PLACAS LATERALES
C04FL1.3
UDS. = 2
ESPESOR = 1 ½"



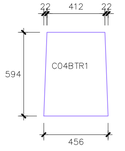
PLACAS LATERALES
C04FL2.1
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C04FL2.2
UDS. = 2
ESPESOR = 1 ½"

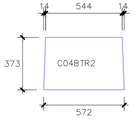
PLACAS LATERALES
C04FL2.3
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C04BTI1
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C04BTR1
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C04BTR2
UDS. = 2
ESPESOR = 1 ½"

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS
BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO
SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 4
UNIDADES = 1 COLUMNA

– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE LA

COLUMNA 4
DESPIECE DE FUSTE
ESCALA 1:20

COLUMNA 4
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PRODEL INGS. Y ARQS. S.A. DE C.V.

ADMINISTRADOR ÚNICO
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE-0885

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 4. VISTAS Y DESPIECE

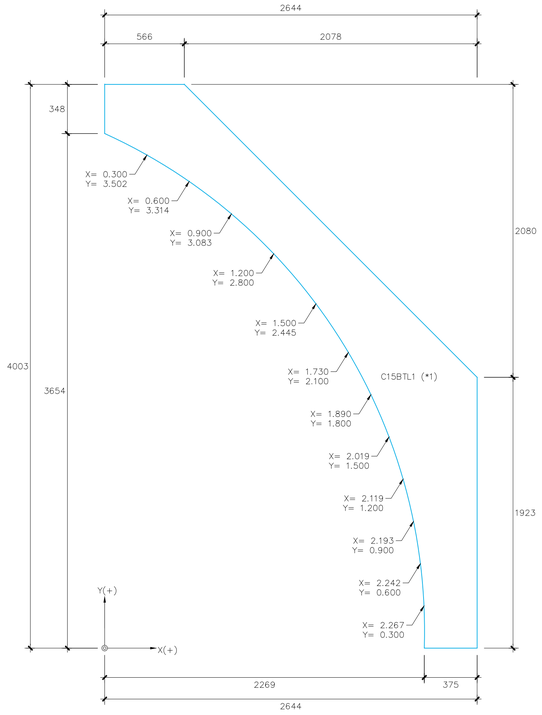
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0031-00232-P-00**

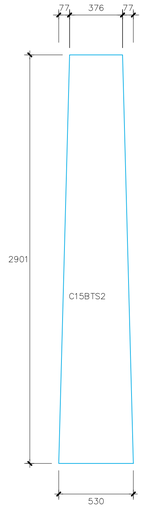
ESCALA GRÁFICA 0 3 9 15

REVISÓ:	DEPTO.	NOMBRE	FIRMA	MOD.: 1:30
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT: METROS

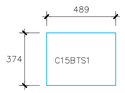
DGOT-20-EST-III-0031-00232-P-00



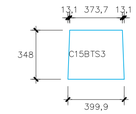
PLACAS
LATERALES
C15BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



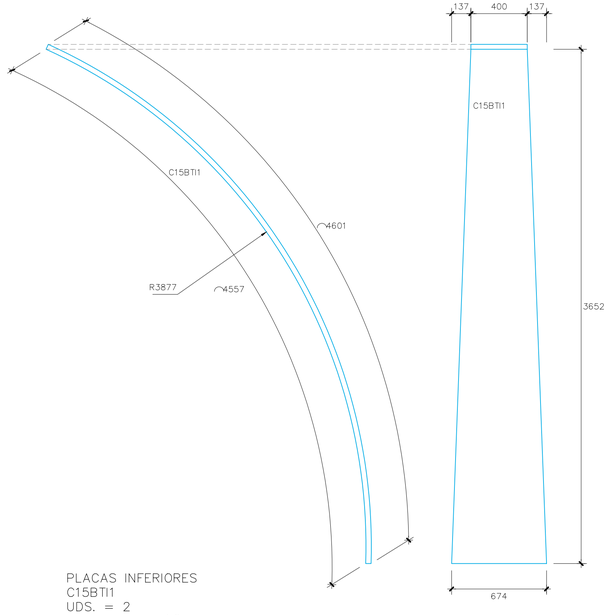
PLACAS SUPERIORES
C15BTS2
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C15BTS1
UDS. = 2
ESPESOR = 1 ½"

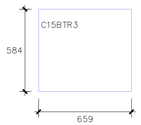


PLACAS SUPERIORES
C15BTS3
UDS. = 2
ESPESOR = 1 ½"

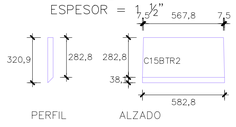


PLACAS INFERIORES
C15BTI1
UDS. = 2
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO

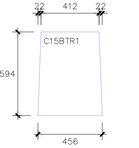


RIGIDIZADORES
C15BTR3
UDS. = 2
ESPESOR = 1 ½"



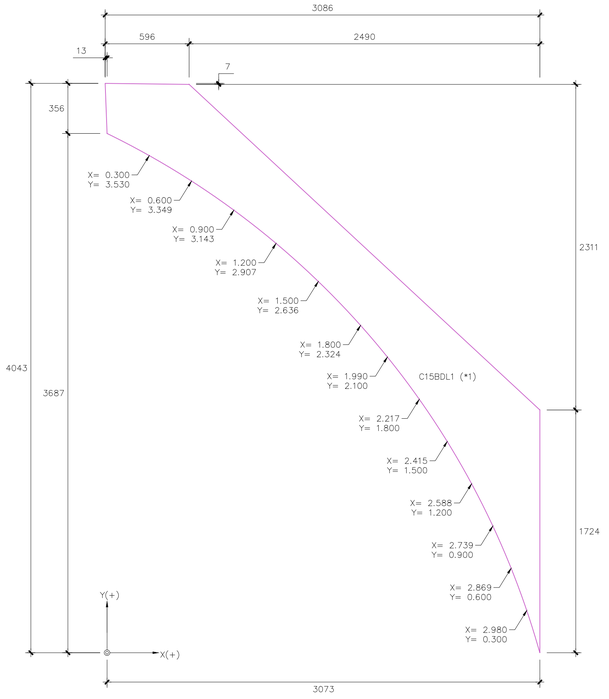
PERFIL ALZADO

RIGIDIZADORES
C15BTR2
UDS. = 2
ESPESOR = 1 ½"

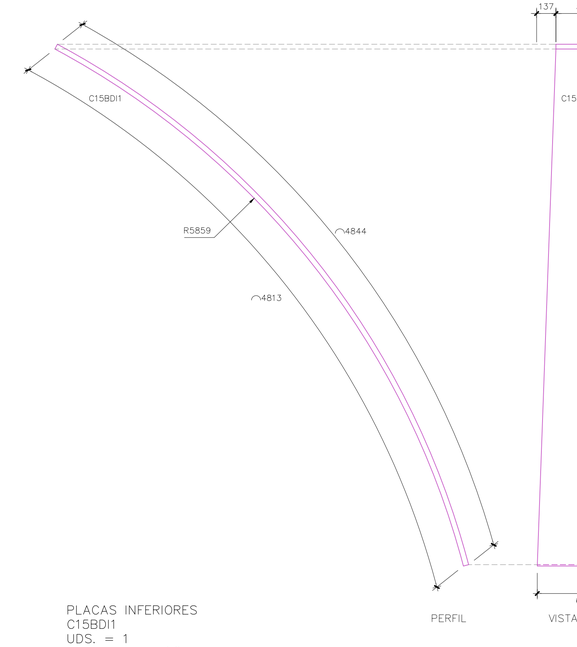


RIGIDIZADORES
C15BTR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 15
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20



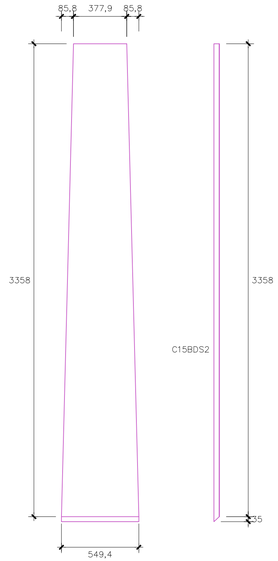
PLACAS
LATERALES
C15BDL1 (*1)
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C15BDI1
UDS. = 1
ESPESOR = 1 ½"

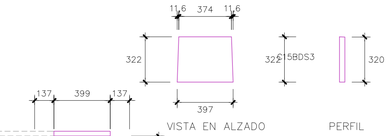
PERFIL VISTA EN ALZADO

COLUMNA 15
DESPIECE DE BRAZO DORSAL
ESCALA 1:20



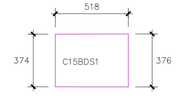
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C15BDS2
UDS. = 1
ESPESOR = 1 ½"

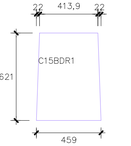


VISTA EN ALZADO PERFIL

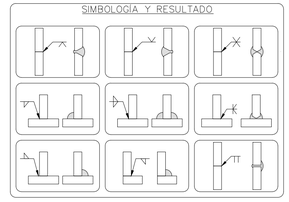
PLACAS SUPERIORES
C15BDS3
UDS. = 1
ESPESOR = 1 ½"



PLACAS SUPERIORES
C15BDS1
UDS. = 1
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C15BDR1
UDS. = 1
ESPESOR = 1 ½"



ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 15
UNIDADES = 1 COLUMNA

- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE LA COLUMNA 15

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 15, DESPIECE (I)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

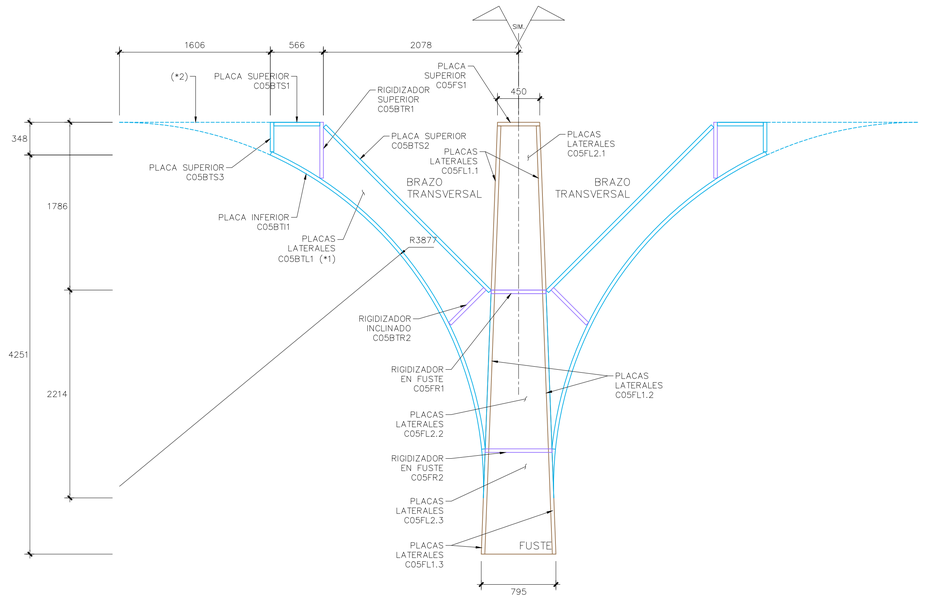
PLANO No.
DGOT-20-EST-III-0054-00255-P-00

ESCALA GRÁFICA: 0.2 0.6 1

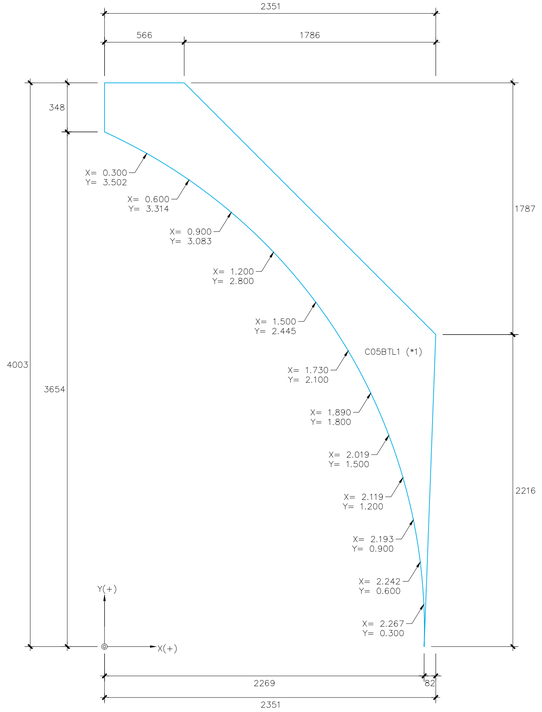
	FECHA	DEPTO.	NOMBRE	FIRMA
DISEÑO		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

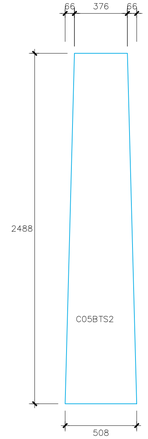
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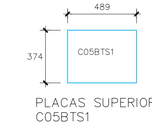
COLUMNA 5. SECCIÓN TRANSVERSAL
ESCALA 1:30



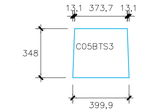
PLACAS LATERALES C05BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



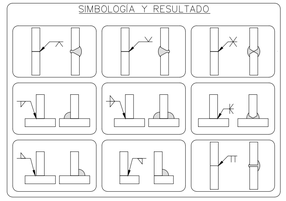
PLACAS SUPERIORES C05BTS2
UDS. = 2
ESPESOR = 1 ½"

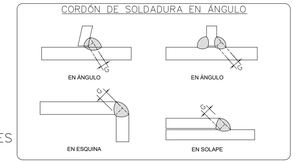


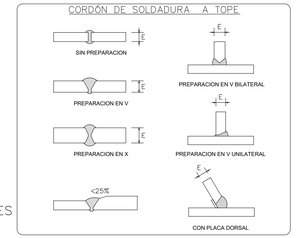
PLACAS SUPERIORES C05BTS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES C05BTS3
UDS. = 2
ESPESOR = 1 ½"







ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

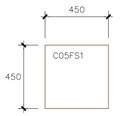
– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

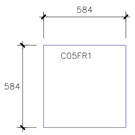
– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 5
UNIDADES = 1 COLUMNA

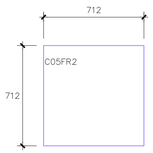
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE LA



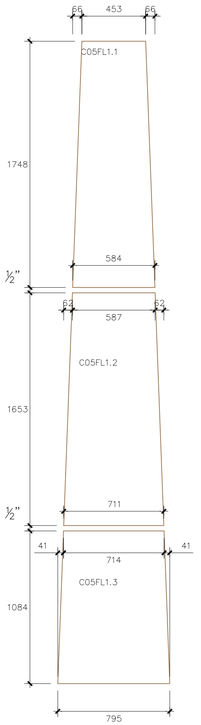
PLACA SUPERIOR
C05FS1
UDS. = 1
ESPESOR = 1 ½"



RIGIDIZADOR
C05FR1
UDS. = 1
ESPESOR = 1 ½"



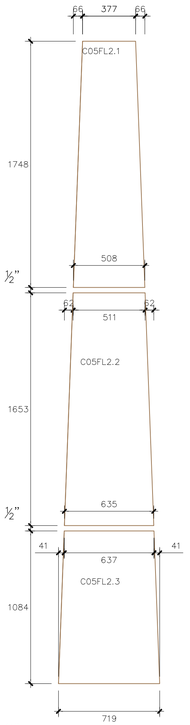
RIGIDIZADOR
C05FR2
UDS. = 1
ESPESOR = 1 ½"



PLACAS LATERALES
C05FL1.1
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C05FL1.2
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C05FL1.3
UDS. = 2
ESPESOR = 1 ½"

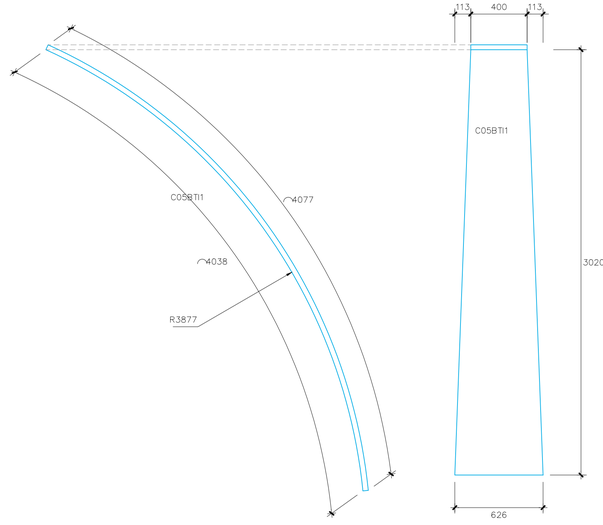


PLACAS LATERALES
C05FL2.1
UDS. = 2
ESPESOR = 1 ½"

PLACAS LATERALES
C05FL2.2
UDS. = 2
ESPESOR = 1 ½"

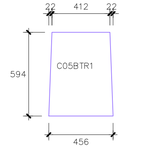
PLACAS LATERALES
C05FL2.3
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 5
DESPIECE DE FUSTE
ESCALA 1:20

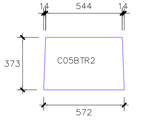


PLACAS INFERIORES
C05BTI1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 5
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20



RIGIDIZADORES
C05BTR1
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C05BTR2
UDS. = 2
ESPESOR = 1 ½"

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0005

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 5. VISTAS Y DESPIECE

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

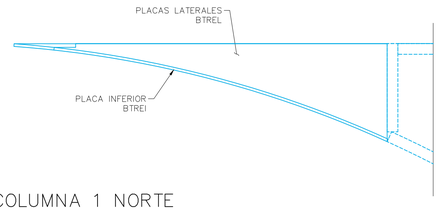
PLANO No.
DGOT-20-EST-III-0032-00233-P-00

ESCALA GRÁFICA
0.3 0.9 1.5

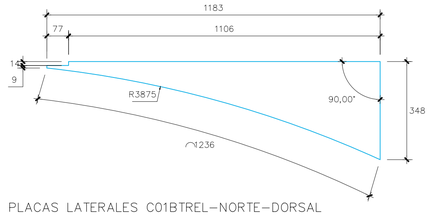
CROQUIS	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD. 1:30
FECHA: JULIO 2021
ESC.
ACOT. METROS

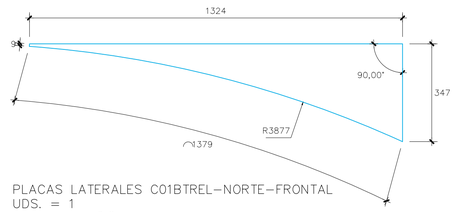
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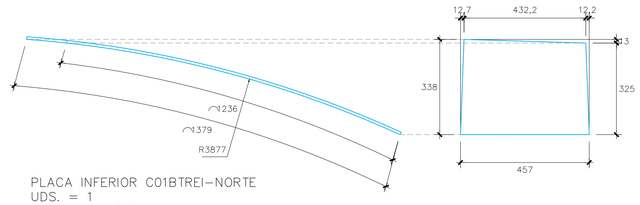
COLUMNA 1 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10



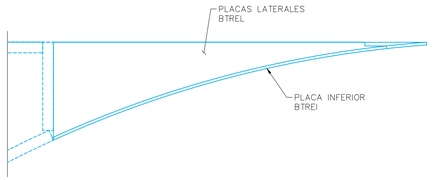
PLACAS LATERALES C01BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = 3/8"



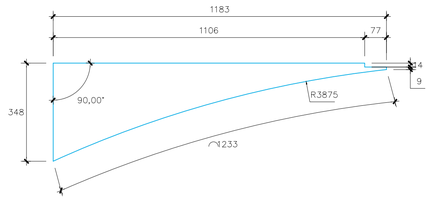
PLACAS LATERALES C01BTREL–NORTE–FRONTAL
UDS. = 1
ESPESOR = 3/8"



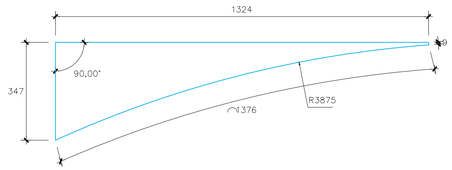
PLACA INFERIOR C01BTREI–NORTE
UDS. = 1
ESPESOR = 3/8"



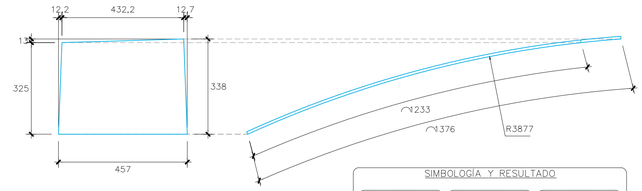
COLUMNA 1 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10



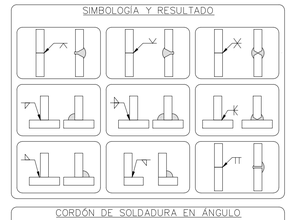
PLACAS LATERALES C01BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = 3/8"

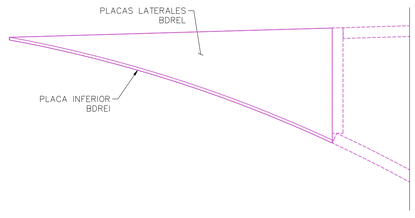


PLACAS LATERALES C01BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = 3/8"

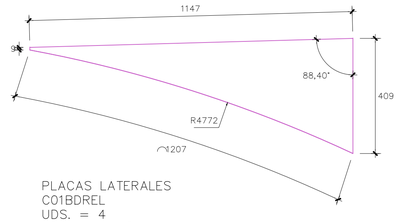


PLACA INFERIOR C01BTREI–SUR
UDS. = 1
ESPESOR = 3/8"

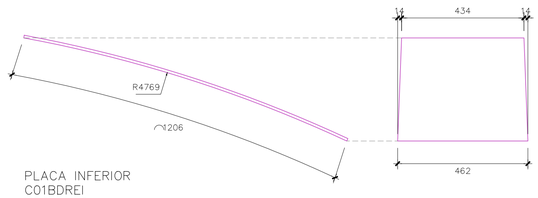




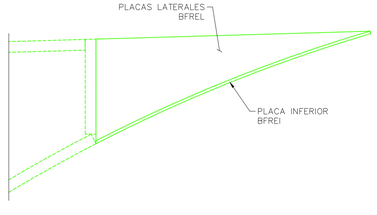
COLUMNA 1
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10



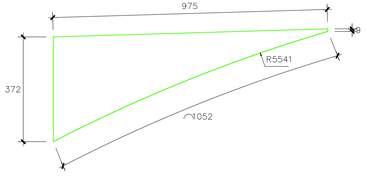
PLACAS LATERALES
C01BDREL
UDS. = 4
ESPESOR = 3/8"



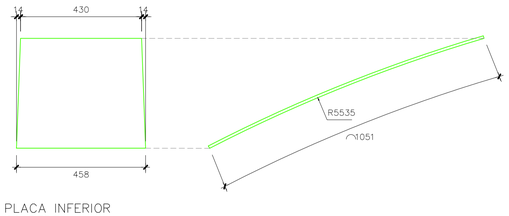
PLACA INFERIOR
C01BDREI
UDS. = 2
ESPESOR = 3/8"



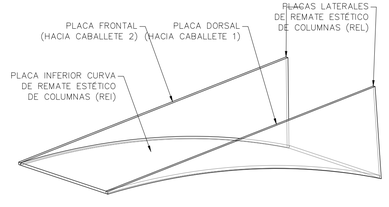
COLUMNA 1
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10



PLACAS LATERALES
C01BFREL
UDS. = 4
ESPESOR = 3/8"



PLACA INFERIOR
C01BFREI
UDS. = 2
ESPESOR = 3/8"



REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0495

APROBO: M. I. DANIEL PÉREZ BELLO

REVISO: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO: M.I. EDUARDO DÁVILA ORTEGA

DIBUJO: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTETICOS SUPERIORES
COLUMNA 1. DESPIECE

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

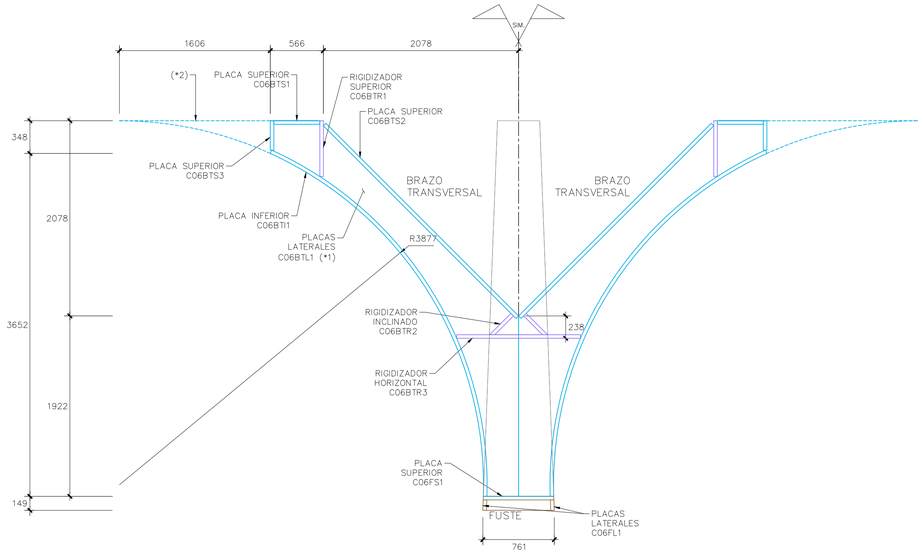
PLANO No.: **DGOT-20-EST-III-0059-00260-P-00**

ESCALA GRÁFICA: 0 0.1 0.3 0.5 1

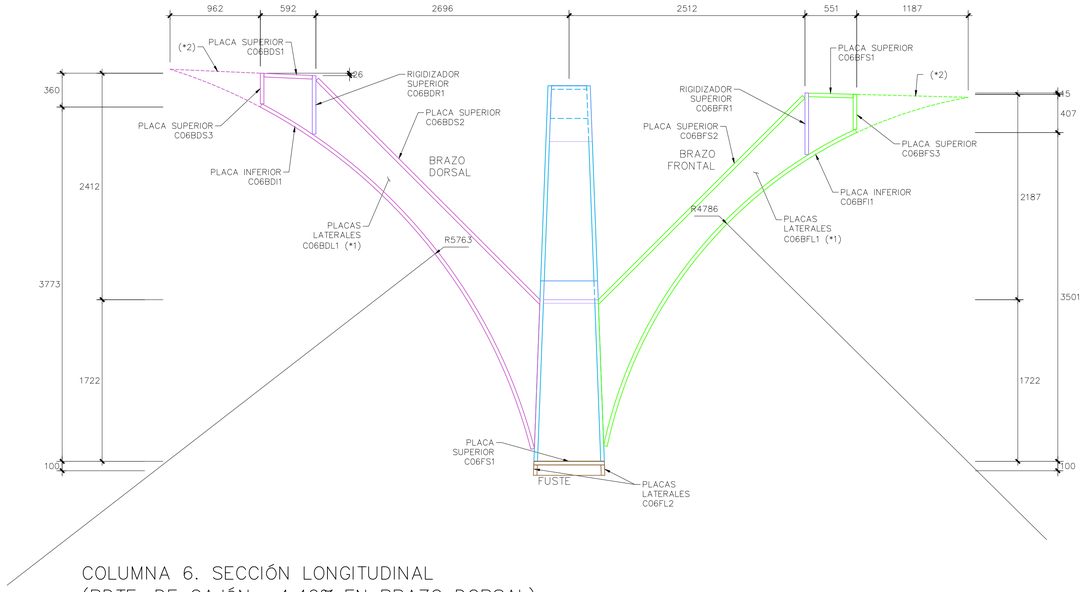
DISEÑÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ	

MOD: 1:10
FECHA: JULIO 2021
ESC:
ACOT: METROS

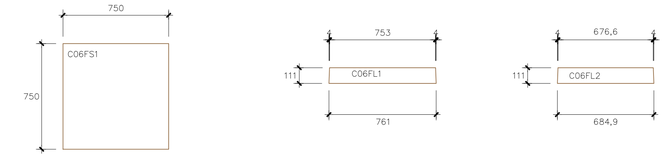
DGOT-20-EST-III-0059-00260-P-00



COLUMNA 6. SECCIÓN TRANSVERSAL
ESCALA 1:30



COLUMNA 6. SECCIÓN LONGITUDINAL
(PDTE. DE CAJÓN= 4.40% EN BRAZO DORSAL)
(PDTE. DE CAJÓN= 2.66% EN BRAZO FRONTAL)
ESCALA 1:30



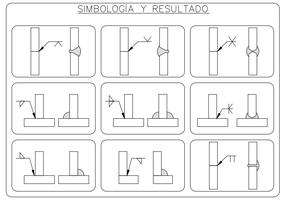
PLACA SUPERIOR
C06FS1
UDS. = 2
ESPESOR = 1 ½"

PLACAS
LATERALES C06FL1
UDS. = 4
ESPESOR = 1 ½"

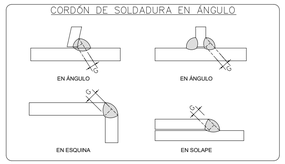
PLACAS
LATERALES
C06FL2
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 6
DESPIECE DE FUSTE
ESCALA 1:20

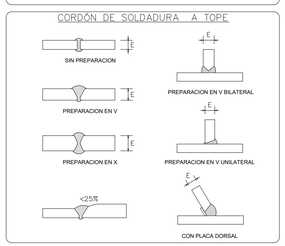
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS COLUMNA 6

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

GOBIERNO DE LA CIUDAD DE MÉXICO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO	DIRECTOR RESPONSABLE DE OBRA	CORRESPONSAL ESTRUCTURAL
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.	ING. ARQ. EDMUNDO REYES MADRID CED. PROF.	ING. LUCIO RAMÓN MONTERO OROZCO CED. PROF.
ING. DAVID S. QUINTERO CAMPOS		

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 6. VISTAS

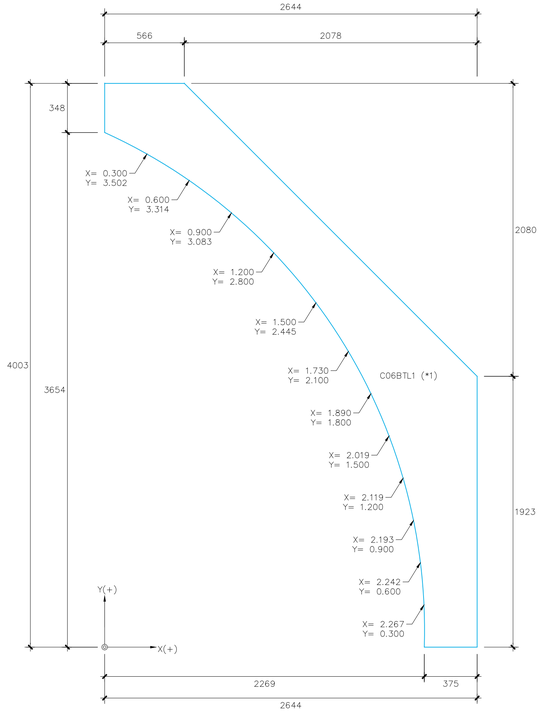
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0033-00234-P-00**

ESCALA GRÁFICA: 0.3 0.9 1.5

FECHA:	DEPTO.	NOMBRE	FIRMA	MOD. 1:30
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT: METROS

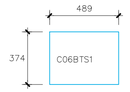
DGOT-20-EST-III-0033-00234-P-00



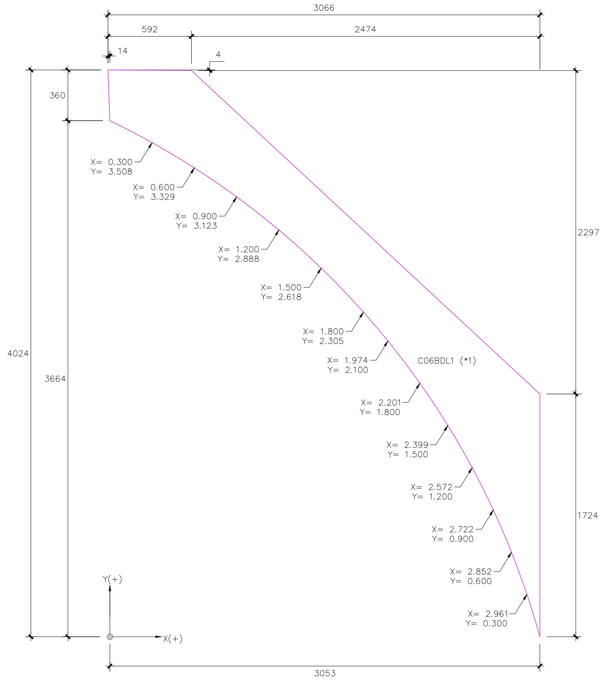
PLACAS
LATERALES
C06BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



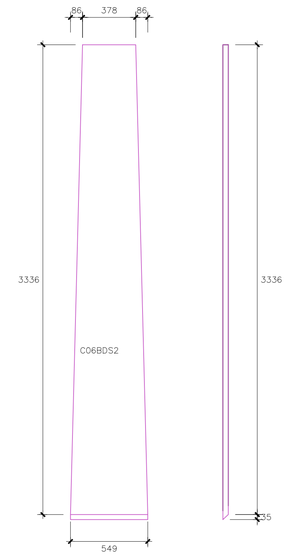
PLACAS SUPERIORES
C06BTS2
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C06BTS1
UDS. = 4
ESPESOR = 1 ½"

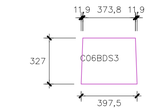


PLACAS
LATERALES
C06BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

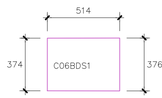


VISTA EN ALZADO PERFIL

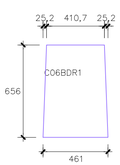
PLACAS SUPERIORES
C06BDS2
UDS. = 2
ESPESOR = 1 ½"



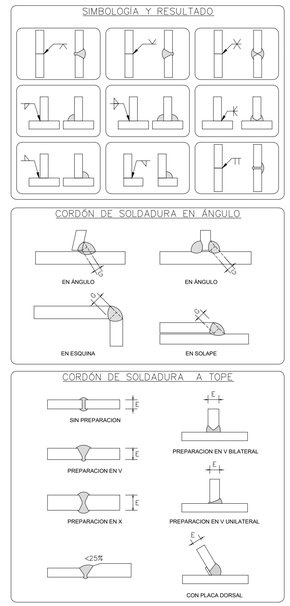
PLACAS SUPERIORES
C06BDS3
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C06BDS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C06BDR1
UDS. = 2
ESPESOR = 1 ½"



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

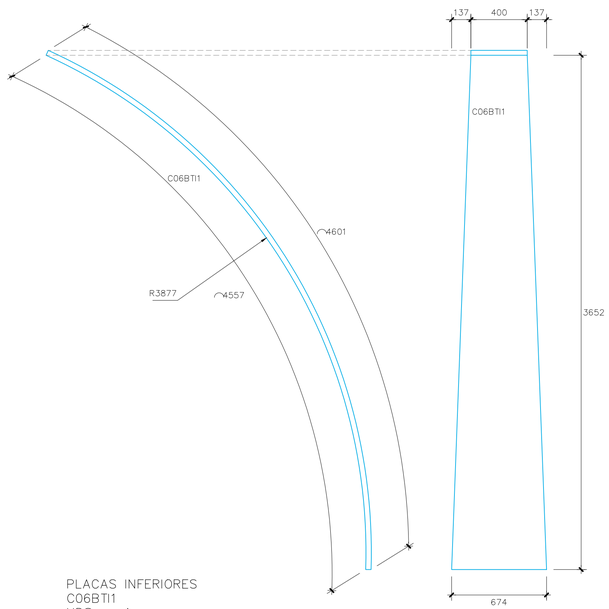
– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.



PLACAS INFERIORES
C06BTI1
UDS. = 4
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO



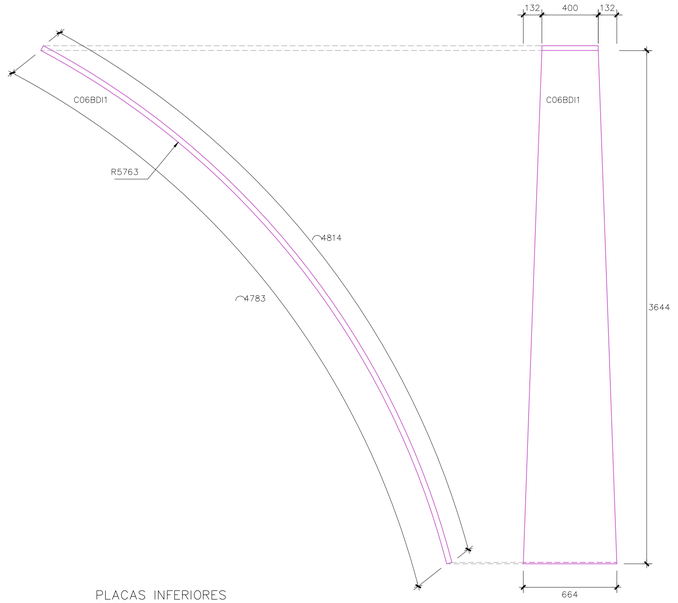
RIGIDIZADORES
C06BTS3
UDS. = 4
ESPESOR = 1 ½"

RIGIDIZADORES
C06BTR3
UDS. = 4
ESPESOR = 1 ½"

PERFIL ALZADO

RIGIDIZADORES
C06BTR2
UDS. = 4
ESPESOR = 1 ½"

RIGIDIZADORES
C06BTR1
UDS. = 4
ESPESOR = 1 ½"



PLACAS INFERIORES
C06BDI1
UDS. = 2
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO

COLUMNA 6
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

COLUMNA 6
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0005

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 6. DESPIECE (I)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

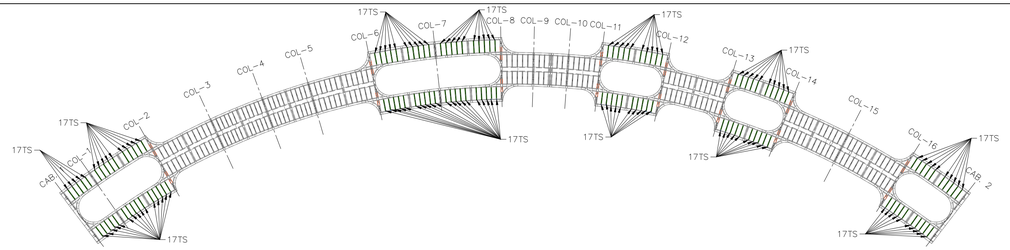
PLANO No.
DGOT-20-EST-III-0034-00235-P-00

ESCALA GRÁFICA: 0 2 4 6 8

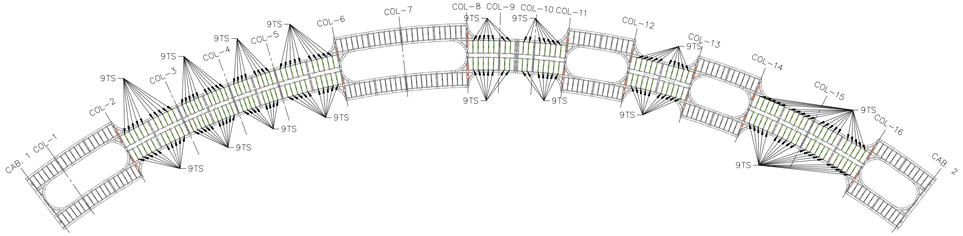
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD.: 1:20
FECHA: JULIO 2021
ESC.:
ACOT.: METROS

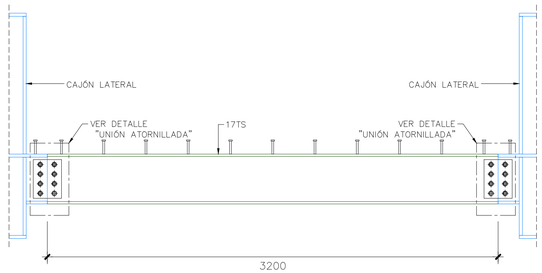
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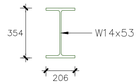
TRAVIESAS SECUNDARIAS (TAB.=17,00m). PLANTA GENERAL
ESCALA 1:500



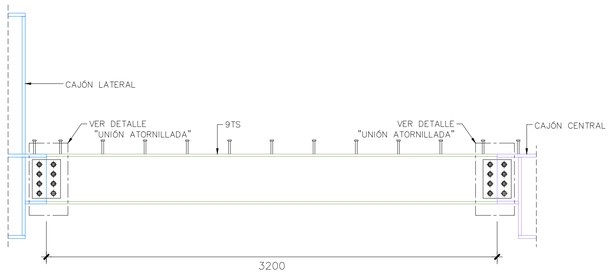
TRAVIESAS SECUNDARIAS (TAB.=9,00m). PLANTA GENERAL
ESCALA 1:500



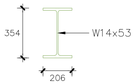
SECCIÓN TRANSVERSAL



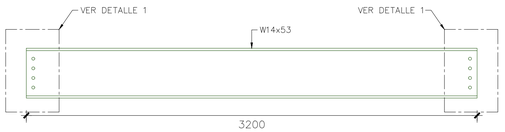
SECCIÓN LONGITUDINAL



SECCIÓN TRANSVERSAL

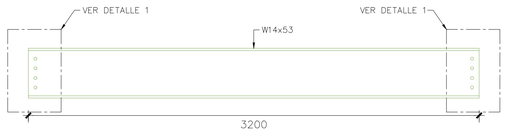


SECCIÓN LONGITUDINAL



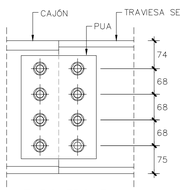
17TS
UDS.= 130

TRAVIESAS SECUNDARIAS (TAB.= 17,00m)
ESCALA 1:20

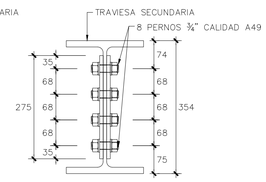


9TS
UDS.= 164

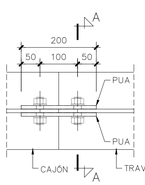
TRAVIESAS SECUNDARIAS (TAB.= 9,00m)
ESCALA 1:20



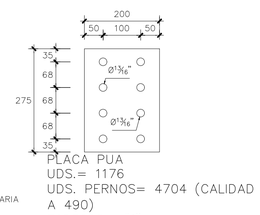
ALZADO FRONTAL



SECCIÓN A –A

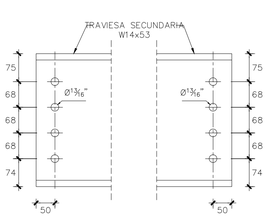


PLANTA



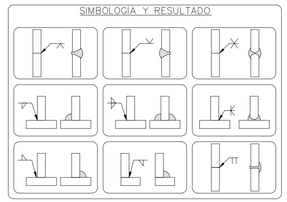
PLACA PUA
UDS.= 1176
UDS. PERNOS= 4704 (CALIDAD A 490)
ESPESOR= ⅜"

DETALLE UNIÓN ATORNILLADA
ESCALA 1:7,5

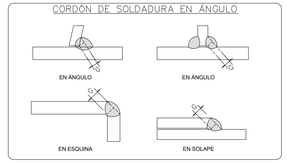


DETALLE 1
ESCALA 1:7,5

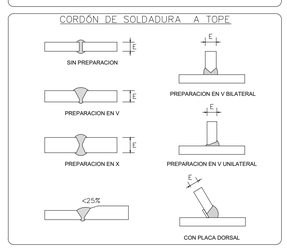
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1455

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0445

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHESA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
TRAVIESAS SECUNDARIAS

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

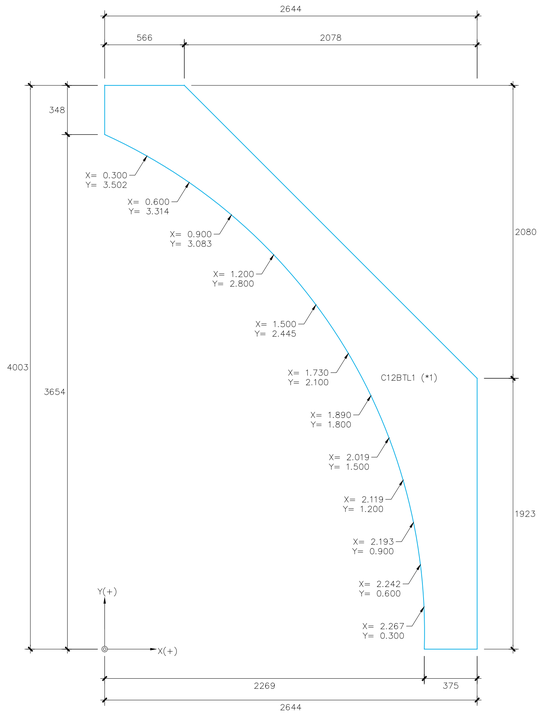
PLANO No.:
DGOT-20-EST-III-0086-00287-P-00

ESCALA GRÁFICA: 0 0.25 1.25 2.5

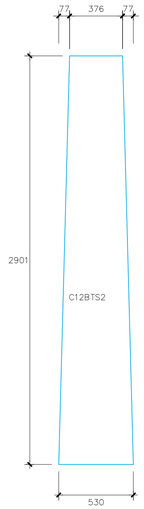
FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INCUENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT.: METROS

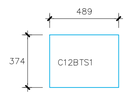
DGOT-20-EST-III-0086-00287-P-00



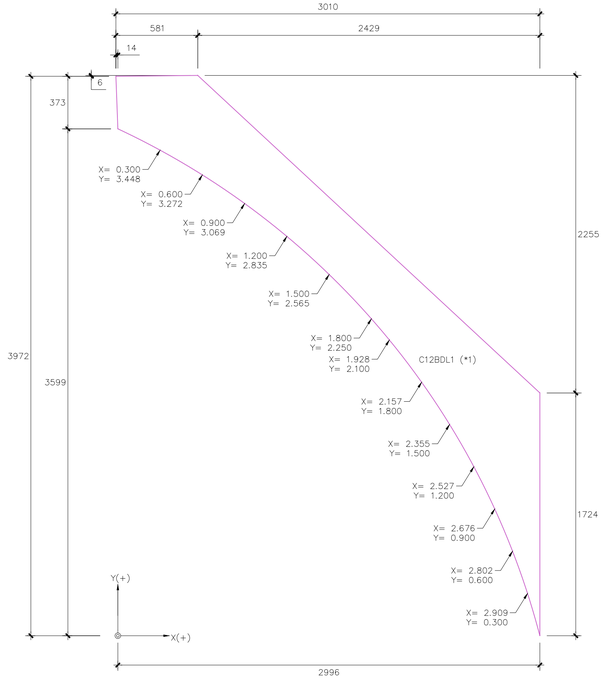
PLACAS
LATERALES
C12BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



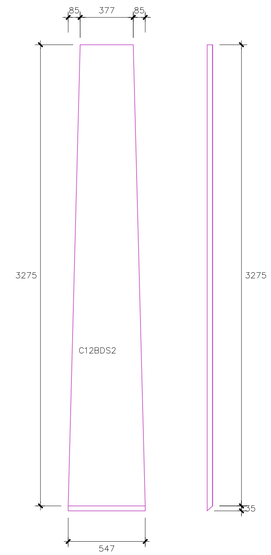
PLACAS SUPERIORES
C12BTS2
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C12BTS1
UDS. = 4
ESPESOR = 1 ½"

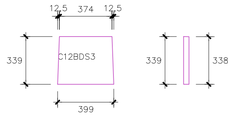


PLACAS
LATERALES
C12BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



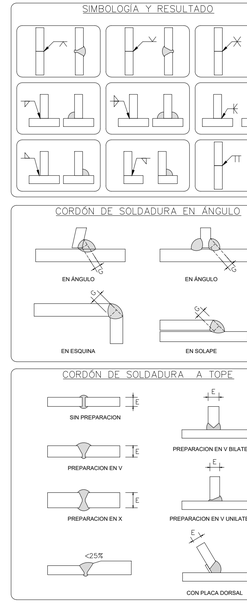
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C12BDS2
UDS. = 2
ESPESOR = 1 ½"



VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C12BDS3
UDS. = 2
ESPESOR = 1 ½"



ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

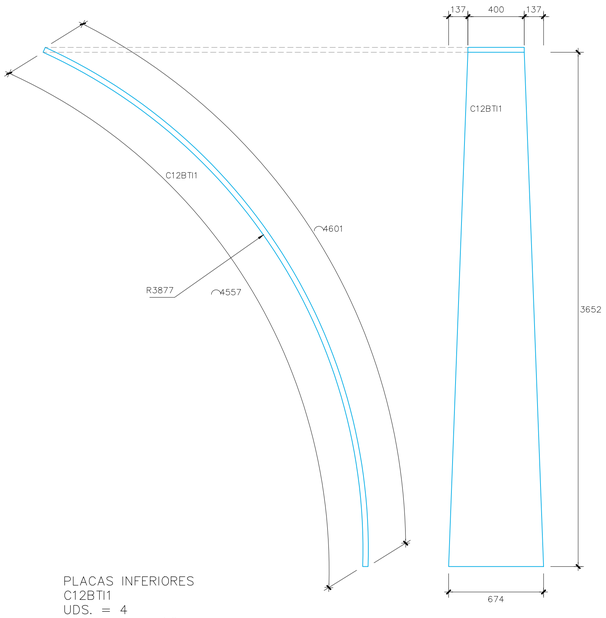
- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 12
UNIDADES = 2 COLUMNAS

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS



PLACAS INFERIORES
C12BTI1
UDS. = 4
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO



PLACAS SUPERIORES
C12BTS3
UDS. = 4
ESPESOR = 1 ½"

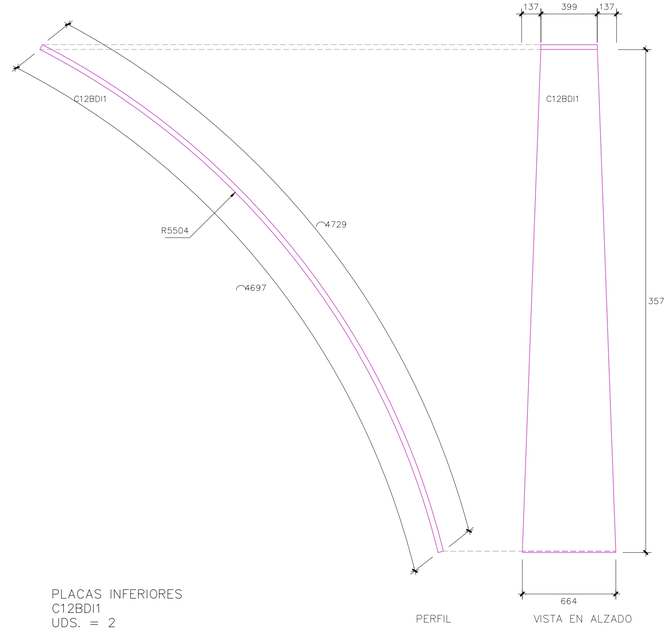
RIGIDIZADORES
C12BTR3
UDS. = 4
ESPESOR = 1 ½"

PERFIL ALZADO

RIGIDIZADORES
C12BTR2
UDS. = 4
ESPESOR = 1 ½"

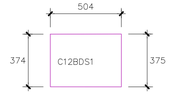
RIGIDIZADORES
C12BTR1
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 12
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

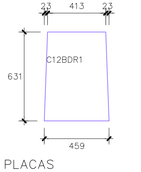


PLACAS INFERIORES
C12BDI1
UDS. = 2
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO



PLACAS SUPERIORES
C12BDS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C12BDR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 12
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MACRO
DRO-1488

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0488

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJO:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN- AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 12. DESPIECE (I)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

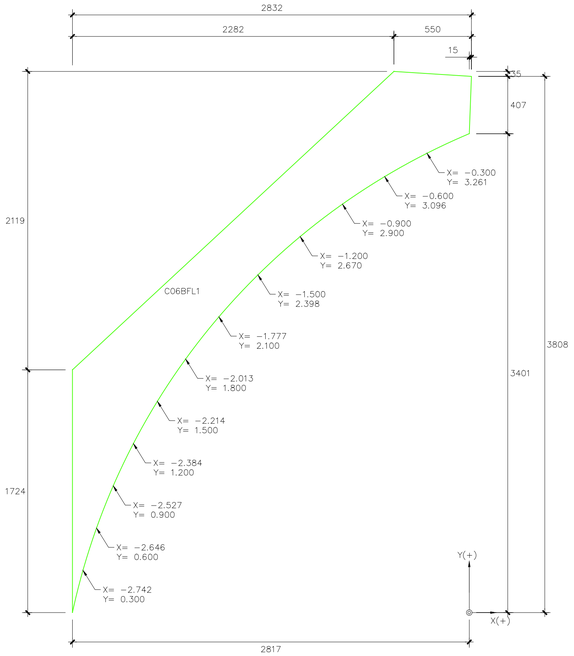
PLANO No.
DGOT-20-EST-III-0045-00246-P-00

ESCALA GRÁFICA: 0 0.5 1

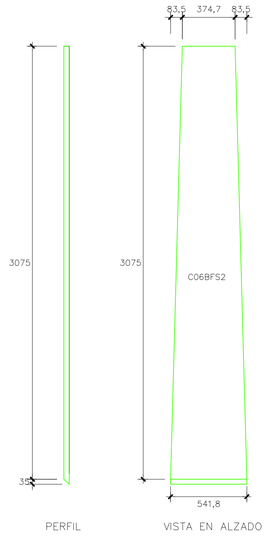
CO-EJE	FECHA	DEPTO	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

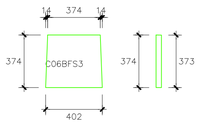
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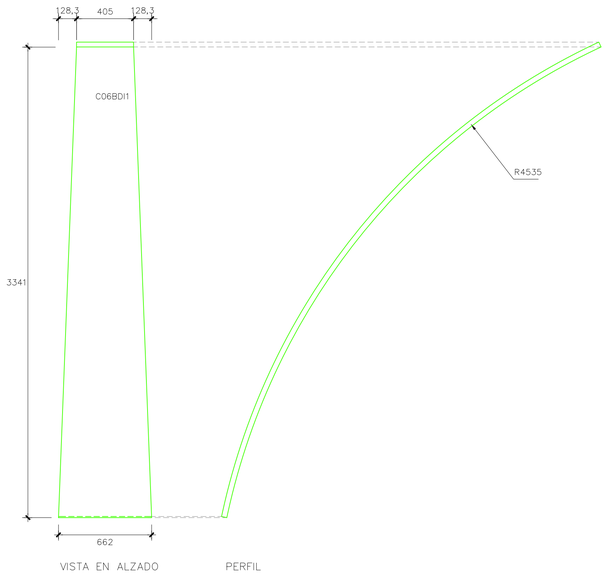
PLACAS
LATERALES
C06BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



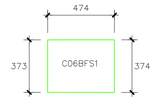
PLACAS SUPERIORES
C06BFS2
UDS. = 2
ESPESOR = 1 ½"



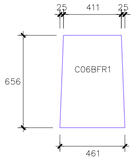
PLACAS SUPERIORES
C06BFS3
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C06BFI1
UDS. = 2
ESPESOR = 1 ½"

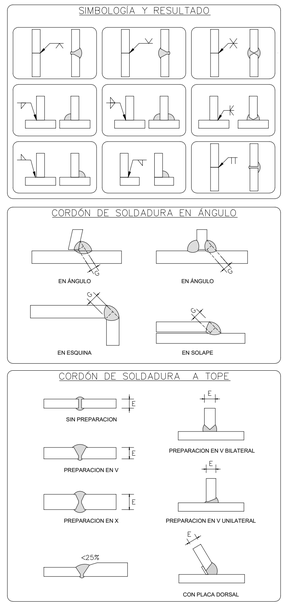


PLACAS SUPERIORES
C06BFS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C06BFR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 6
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 6

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0295

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJO:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 6. DESPIECE (II)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

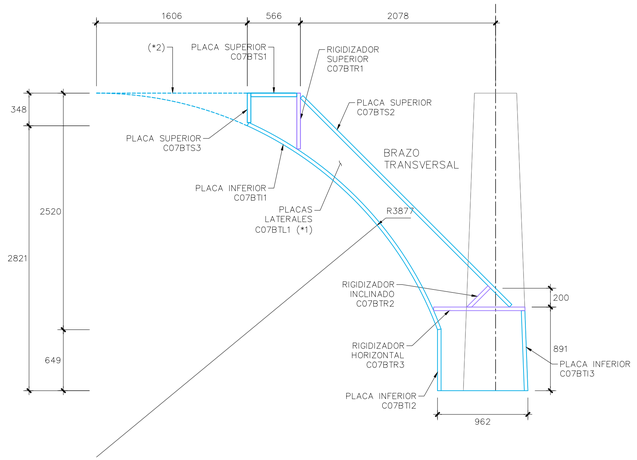
PLANO No.
DGOT-20-EST-III-0035-00236-P-00

ESCALA GRÁFICA: 0 0.5 1

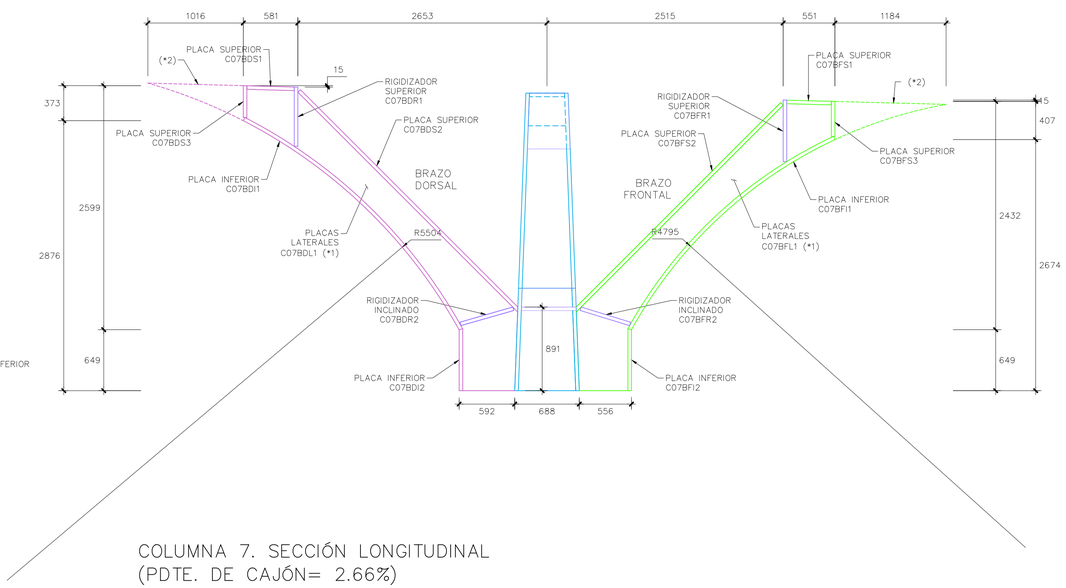
FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

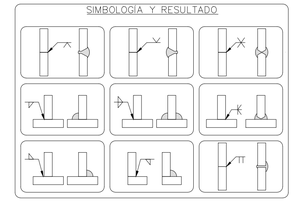
DGOT-20-EST-III-0035-00236-P-00

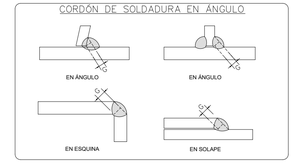


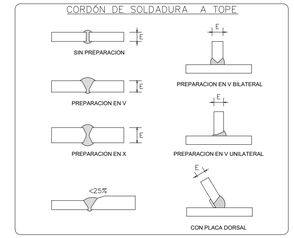
COLUMNA 7. SECCIÓN TRANSVERSAL
ESCALA 1:30
SE REPRESENTA LA COLUMNA 7 NORTE. IA COLUMNA 7 SUR ES SIMÉTRICA

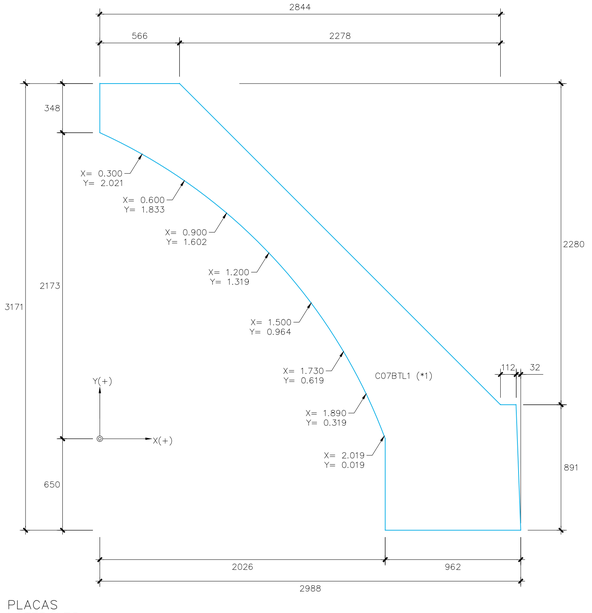


COLUMNA 7. SECCIÓN LONGITUDINAL
(PDTE. DE CAJÓN= 2.66%)
ESCALA 1:30

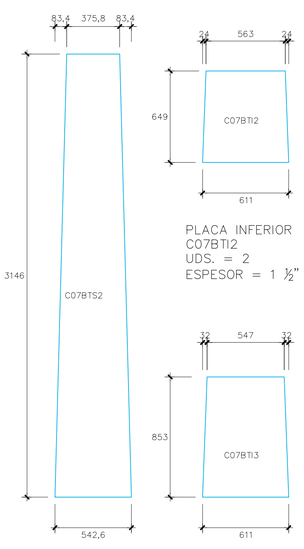








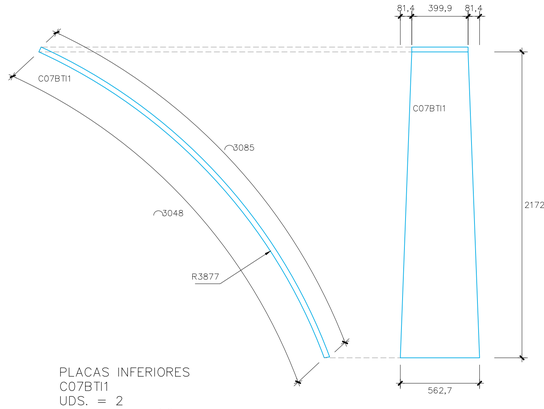
PLACAS LATERALES
C07BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



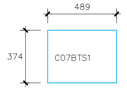
PLACAS SUPERIORES
C07BTS2
UDS. = 2
ESPESOR = 1 ½"

PLACA INFERIOR
C07BTI2
UDS. = 2
ESPESOR = 1 ½"

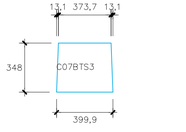
PLACA INFERIOR
C07BTI3
UDS. = 2
ESPESOR = 1 ½"



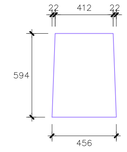
PLACAS INFERIORES
C07BTI1
UDS. = 2
ESPESOR = 1 ½"



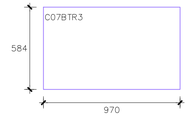
PLACAS SUPERIORES
C07BTS1
UDS. = 2
ESPESOR = 1 ½"



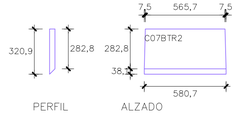
PLACAS SUPERIORES
C07BTS3
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C07BTR1
UDS. = 4
ESPESOR = 1 ½"



RIGIDIZADORES
C07BTR3
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C07BTR2
UDS. = 2
ESPESOR = 1 ½"

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS

COLUMNA 7

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

COLUMNA 7
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBO	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

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MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
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ADMINISTRADOR ÚNICO
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CVE-1495

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJO:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 7. VISTAS Y DESPIECE (I)

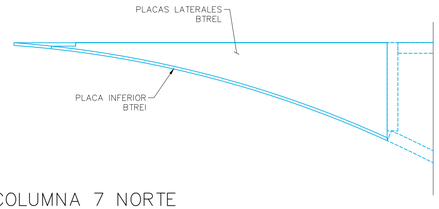
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: DGOT-20-EST-III-0036-00237-P-00

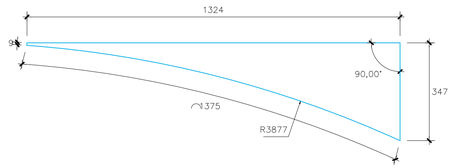
ESCALA GRÁFICA: 0 0.5 0.9 1.5

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD: 1:30
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

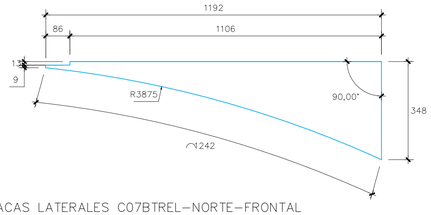
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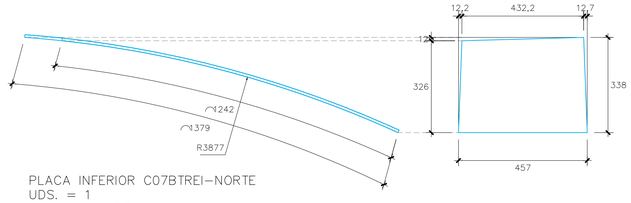
COLUMNA 7 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10



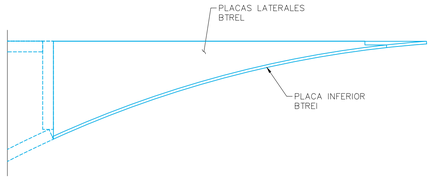
PLACAS LATERALES C07BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = 3/8"



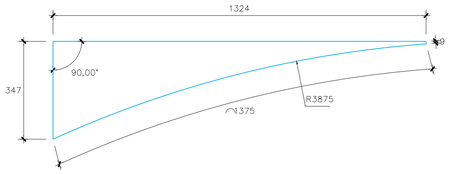
PLACAS LATERALES C07BTREL–NORTE–FRONTAL
UDS. = 1
ESPESOR = 3/8"



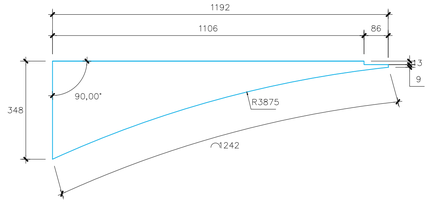
PLACA INFERIOR C07BTREI–NORTE
UDS. = 1
ESPESOR = 3/8"



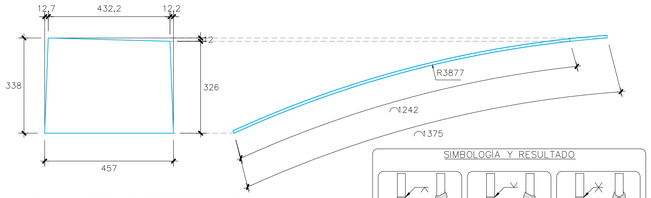
COLUMNA 7 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10



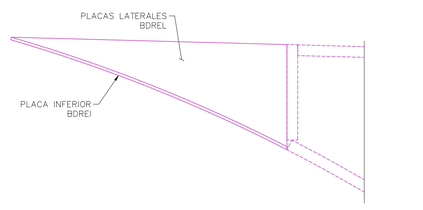
PLACAS LATERALES C07BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = 3/8"



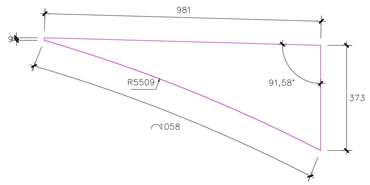
PLACAS LATERALES C07BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = 3/8"



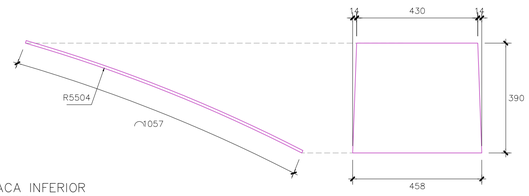
PLACA INFERIOR C07BTREI–SUR
UDS. = 1
ESPESOR = 3/8"



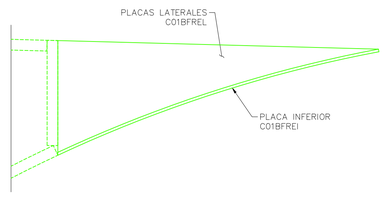
COLUMNA 7
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10



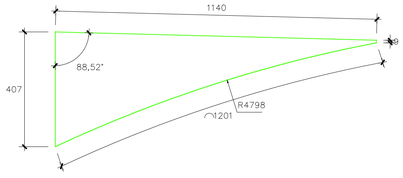
PLACAS LATERALES
C07BDREL
UDS. = 4
ESPESOR = 3/8"



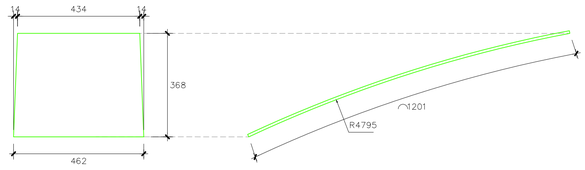
PLACA INFERIOR
C07BDREI
UDS. = 2
ESPESOR = 3/8"



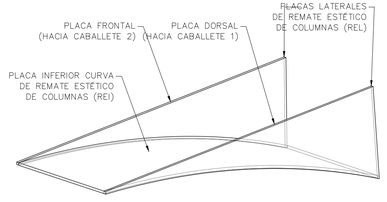
COLUMNA 7
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10



PLACAS LATERALES
C07BFREL
UDS. = 4
ESPESOR = 3/8"



PLACA INFERIOR
C07BFREI
UDS. = 2
ESPESOR = 3/8"

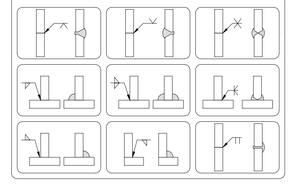


REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

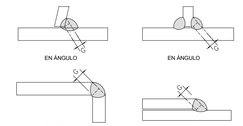
REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

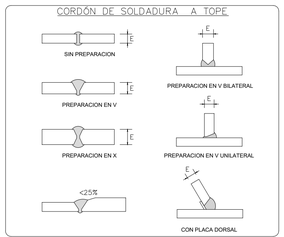
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PRODEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
PRODEL INGENIERÍA Y ARQUITECTURA S.A. DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MAIRO
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 7, DESPIECE

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

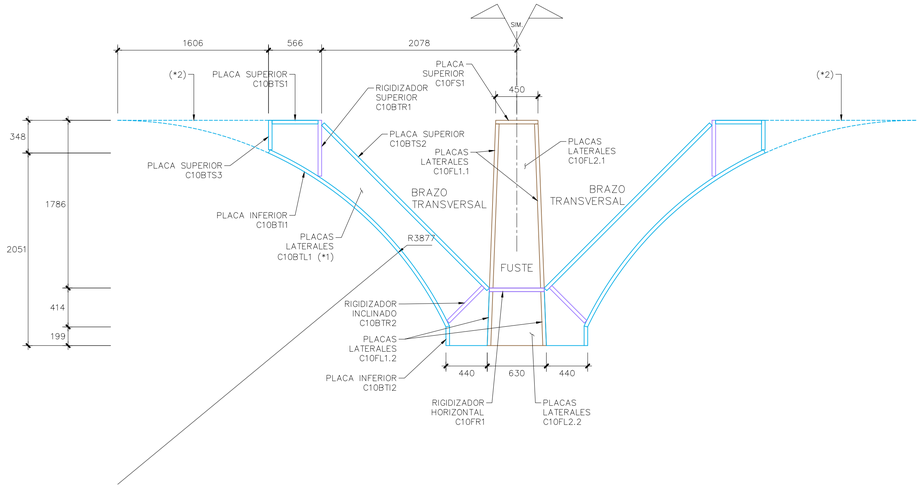
PLANO No.
DGOT-20-EST-III-0063-00264-P-00

ESCALA GRÁFICA
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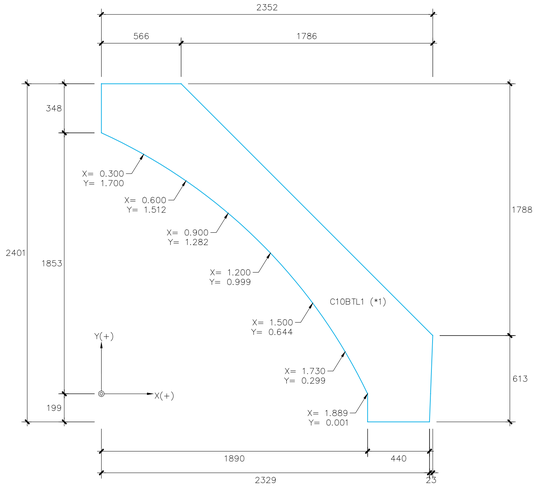
REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

MOD. 1:10
FECHA: JULIO 2021
ESC.
ACOT. METROS

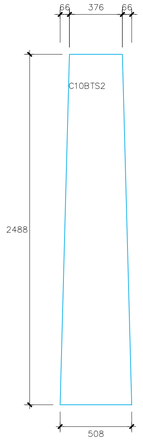
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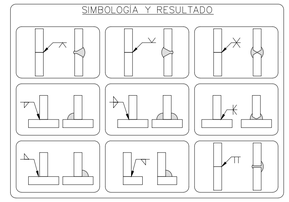
COLUMNA 10. SECCIÓN TRANSVERSAL
ESCALA 1:30

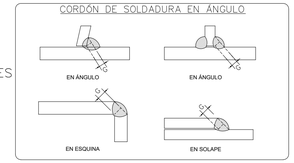


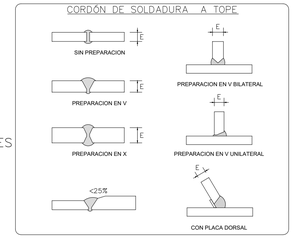
PLACAS LATERALES
C10BTL1 (*1)
UDS. = 4
ESPESOR = 1 ½"

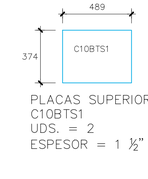


PLACAS SUPERIORES
C10BTS2
UDS. = 2
ESPESOR = 1 ½"

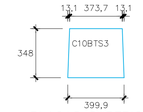








PLACAS SUPERIORES
C10BTS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS SUPERIORES
C10BTS3
UDS. = 2
ESPESOR = 1 ½"

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

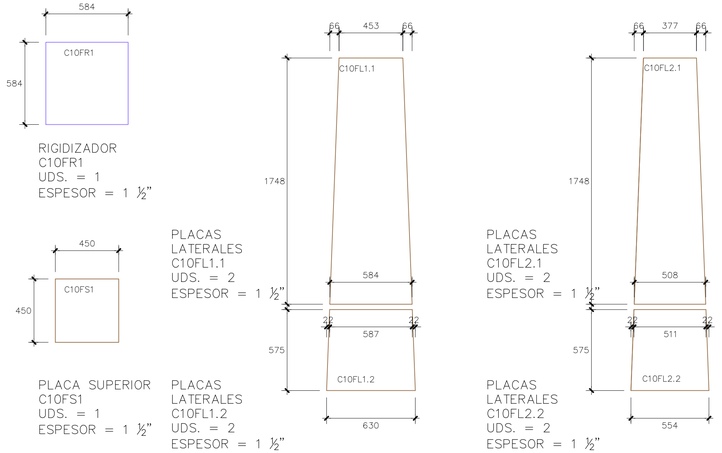
– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

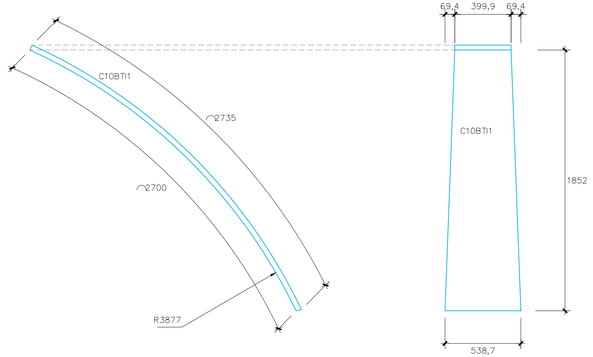
– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES EN COLUMNA 10

– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE UNA COLUMNA.



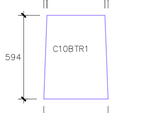
COLUMNA 10
DESPIECE DE FUSTE
ESCALA 1:20



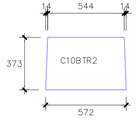
PLACAS INFERIORES
C10BTI1
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C10BTI2
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C10BTR1
UDS. = 2
ESPESOR = 1 ½"



RIGIDIZADORES
C10BTR2
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 10
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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ING. HUGO FLORES SANCHEZ

PRODEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
PRODEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE-0885

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 10. VISTAS Y DESPIECE

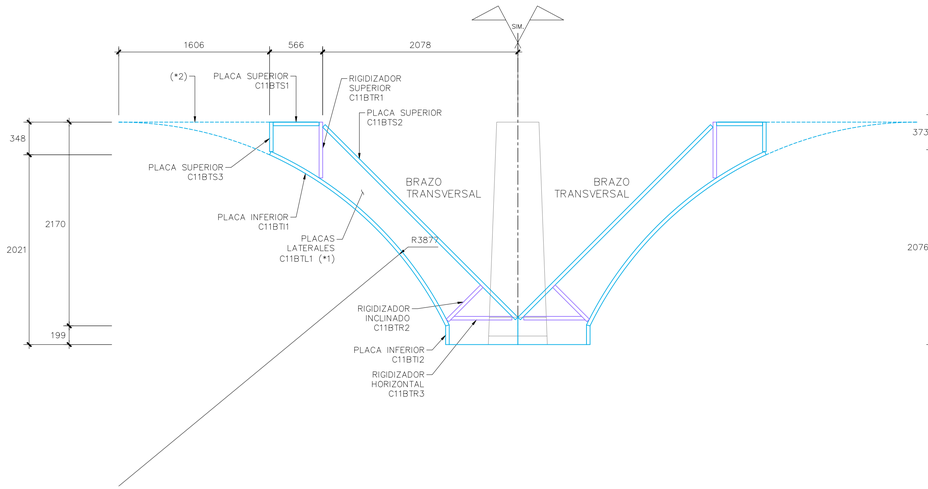
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0041-00242-P-00**

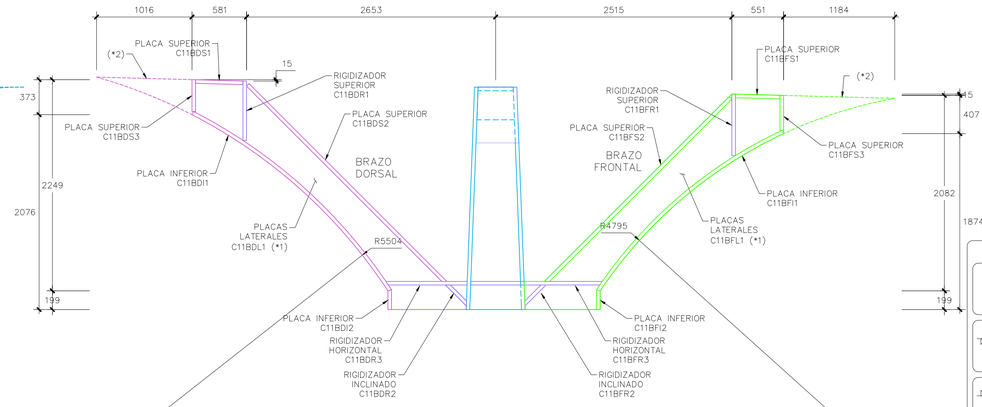
ESCALA GRAFICA: 0 8 16 24 32

FECHA:	DEPTO	NOMBRE	FIRMA	MOD.: 1:30
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ARQ. IÑAKIO CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC.
				ACOT. METROS

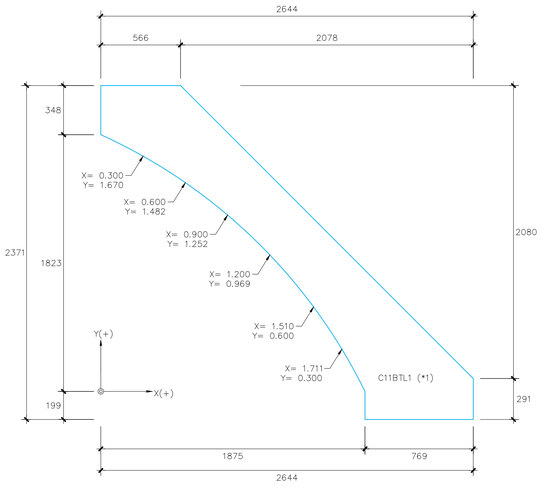
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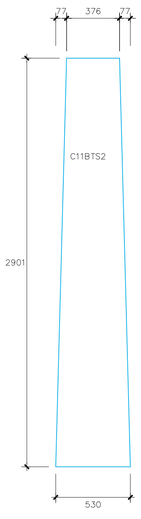
COLUMNA 11. SECCIÓN TRANSVERSAL
ESCALA 1:30



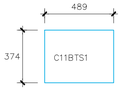
COLUMNA 11. SECCIÓN LONGITUDINAL
(PDTE. DE CAJÓN= 2.66%)
ESCALA 1:30



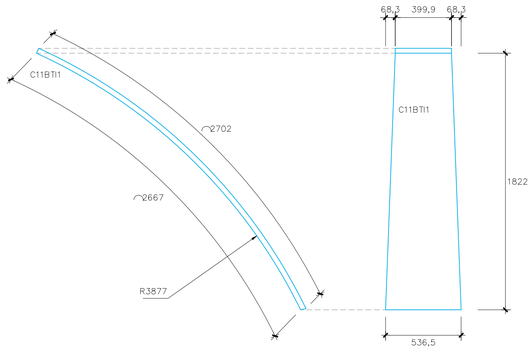
PLACAS LATERALES
C11BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



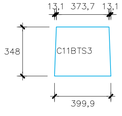
PLACAS SUPERIORES
C11BTS2
UDS. = 4
ESPESOR = 1 ½"



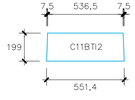
PLACAS SUPERIORES
C11BTS1
UDS. = 4
ESPESOR = 1 ½"



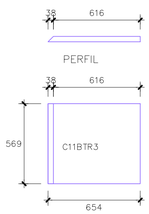
PLACAS INFERIORES
C11BTI1
UDS. = 4
ESPESOR = 1 ½"



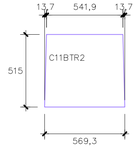
PLACAS SUPERIORES
C11BTS3
UDS. = 4
ESPESOR = 1 ½"



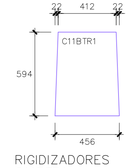
PLACAS INFERIORES
C11BTI2
UDS. = 4
ESPESOR = 1 ½"



RIGIDIZADORES
C11BTR3
UDS. = 4
ESPESOR = 1 ½"

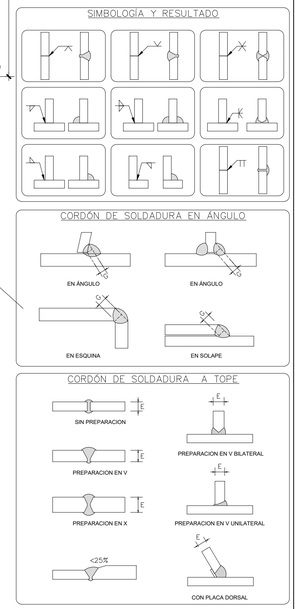


RIGIDIZADORES
C11BTR2
UDS. = 4
ESPESOR = 1 ½"



RIGIDIZADORES
C11BTR1
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 11
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 11

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

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JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1426

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COR-0456

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 11. VISTAS Y DESPIECE (I)

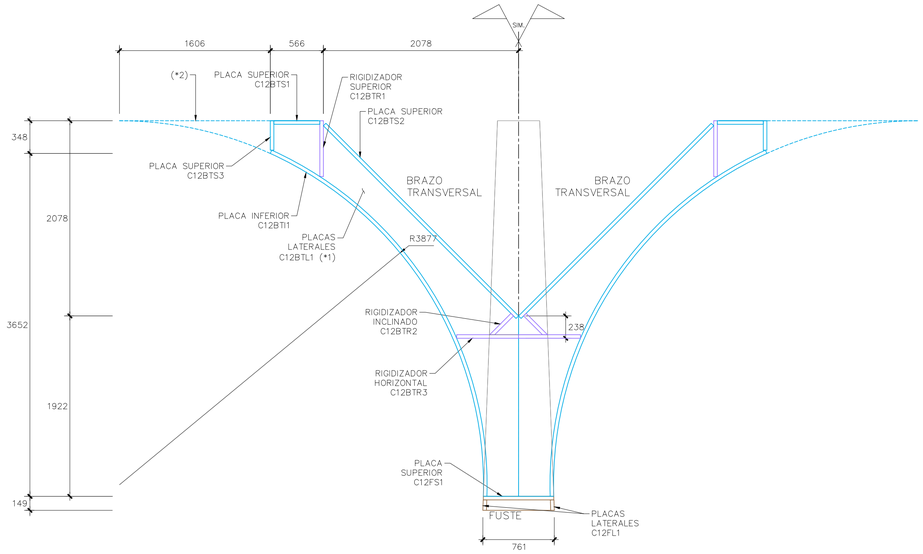
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0042-00243-P-00**

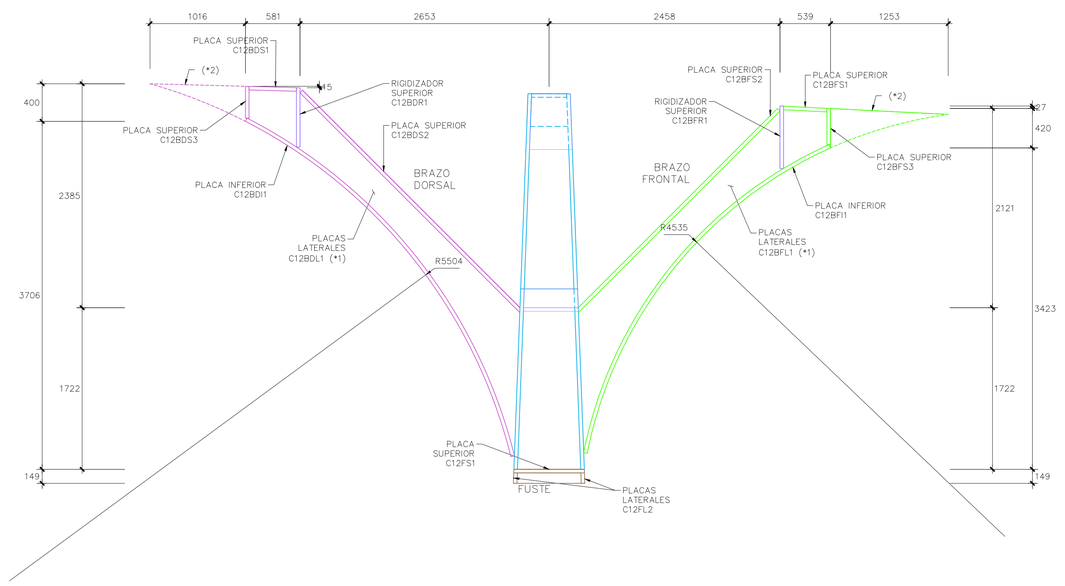
ESCALA GRÁFICA: 0 0.5 0.9 1.5

	FECHA:	DEPTO:	NOMBRE:	FIRMA:	
DISEÑÓ		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD: 1:30
		ESTRUCTURA	M.I. ÁNGEL RAMOS CAPISTRÁN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

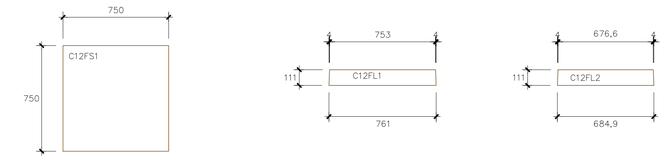
DGOT-20-EST-III-0042-00243-P-00



COLUMNA 12. SECCIÓN TRANSVERSAL
ESCALA 1:30



COLUMNA 12. SECCIÓN LONGITUDINAL
(PDTE. DE CAJÓN= 2.66% EN BRAZO DORSAL)
(PDTE. DE CAJÓN= 5.00% EN BRAZO FRONTAL)
ESCALA 1:30



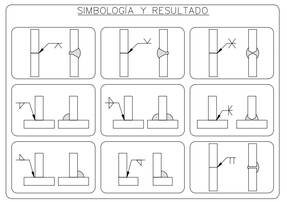
PLACA SUPERIOR
C12FS1
UDS. = 2
ESPESOR = 1 ½"

PLACAS
LATERALES C12FL1
UDS. = 4
ESPESOR = 1 ½"

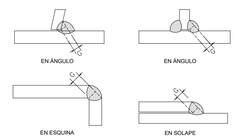
PLACAS
LATERALES
C12FL2
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 12
DESPIECE DE FUSTE
ESCALA 1:20

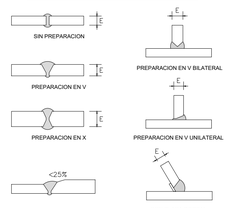
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A DE C.V.
ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 12. VISTAS

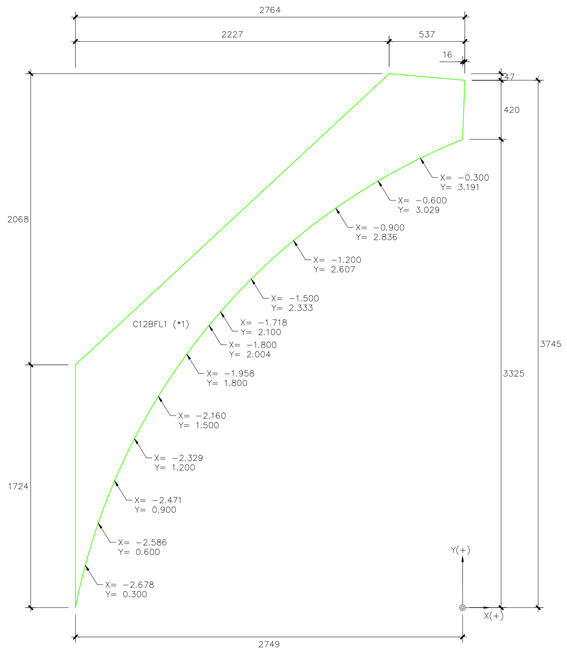
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0044-00245-P-00

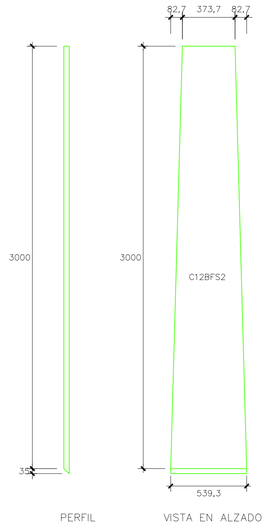
ESCALA GRÁFICA: 0.3 0.9 1.5

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:30
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

DGOT-20-EST-III-0044-00245-P-00

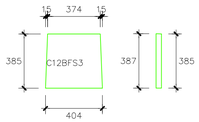


PLACAS
LATERALES
C12BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



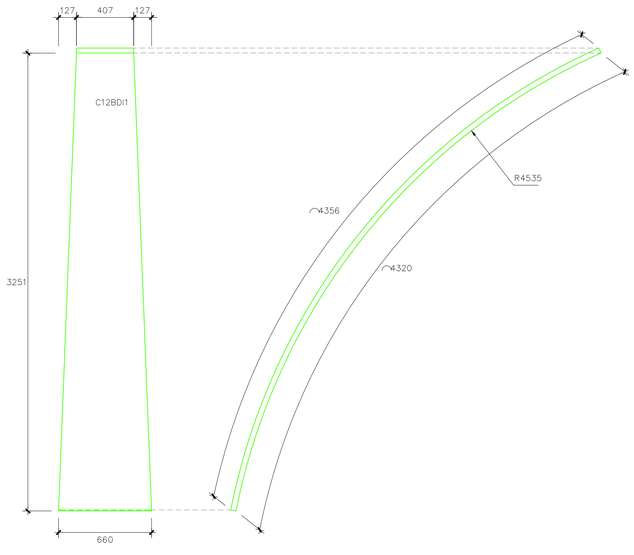
PERFIL VISTA EN ALZADO

PLACAS SUPERIORES
C12BFS2
UDS. = 2
ESPESOR = 1 ½"



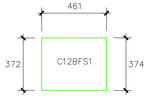
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C12BFS3
UDS. = 2
ESPESOR = 1 ½"

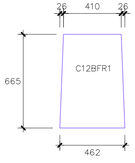


VISTA EN ALZADO PERFIL

PLACAS INFERIORES
C12BFI1
UDS. = 2
ESPESOR = 1 ½"



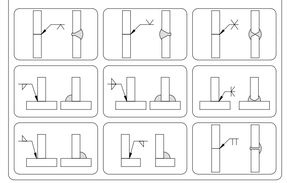
PLACAS SUPERIORES
C12BFS1
UDS. = 2
ESPESOR = 1 ½"



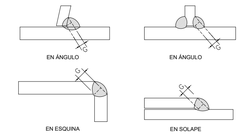
PLACAS
RIGIDIZADORAS
C12BFR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 12
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20

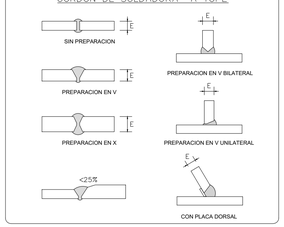
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 12
UNIDADES = 2 COLUMNAS

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0295

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 12. DESPIECE (II)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

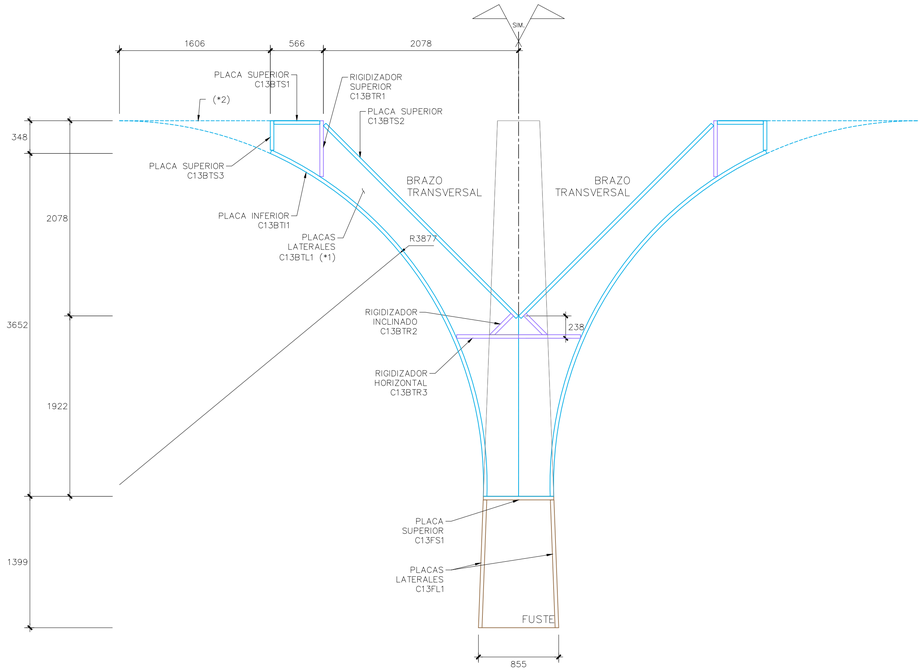
PLANO No.
DGOT-20-EST-III-0046-00247-P-00

ESCALA GRÁFICA: 0 0.2 0.6 1

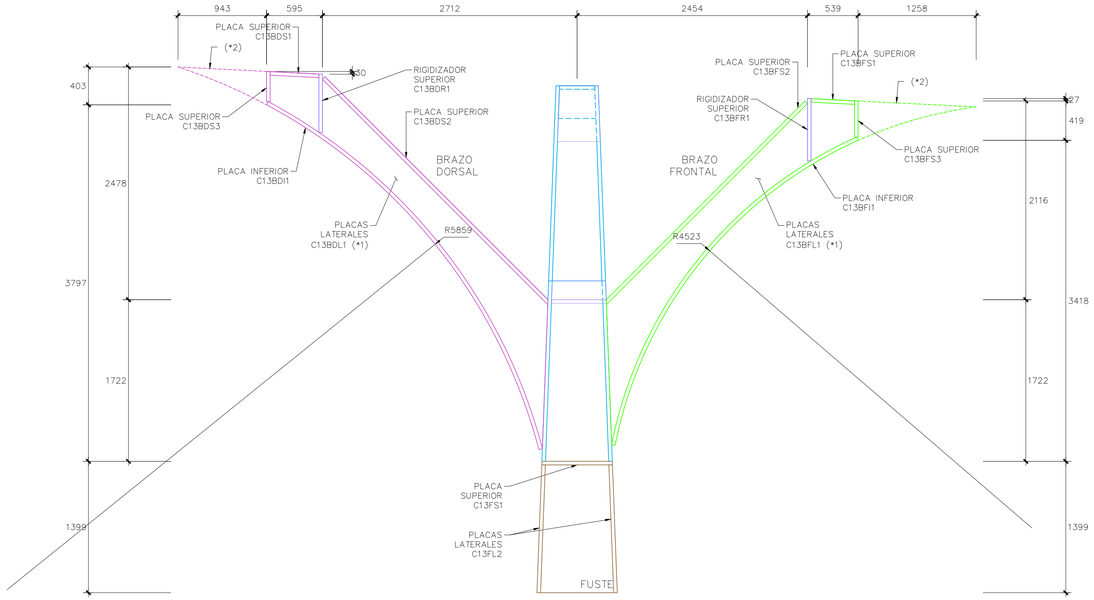
CO-DI-CE	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

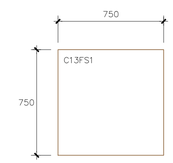
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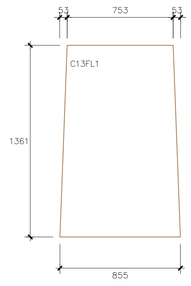
COLUMNA 13. SECCIÓN TRANSVERSAL
ESCALA 1:30



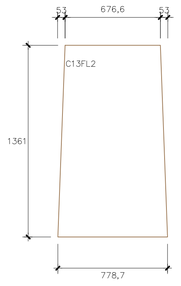
COLUMNA 13. SECCIÓN LONGITUDINAL
(PDTE. DE CAJÓN= 5%)
ESCALA 1:30



PLACA SUPERIOR
C13FS1
UDS. = 2
ESPESOR = 1 ½"



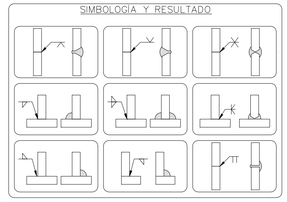
PLACAS
LATERALES C13FL1
UDS. = 4
ESPESOR = 1 ½"



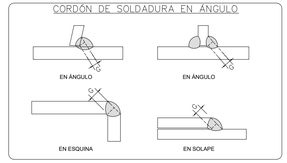
PLACAS
LATERALES
C13FL2
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 13
DESPIECE DE FUSTE
ESCALA 1:20

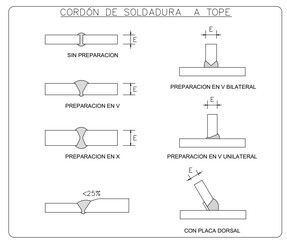
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

- PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
- EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

- LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
- SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
- LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
- ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

COLUMNA 13
UNIDADES = 2 COLUMNAS

- EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
- LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1466

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CVE 0466

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 13. VISTAS

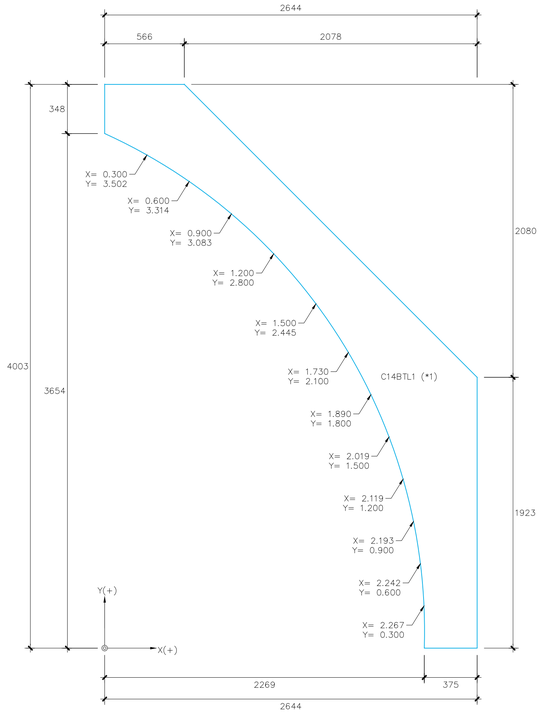
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: DGOT-20-EST-III-0047-00248-P-00

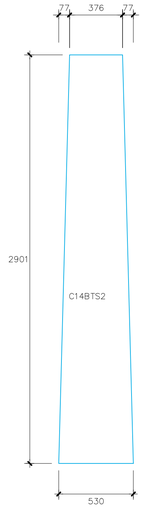
ESCALA GRÁFICA: 0.3 0.9 1.5

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:30
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

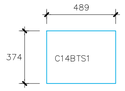
DGOT-20-EST-III-0047-00248-P-00



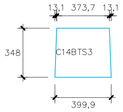
PLACAS
LATERALES
C14BTL1 (*1)
UDS. = 8
ESPESOR = 1 ½"



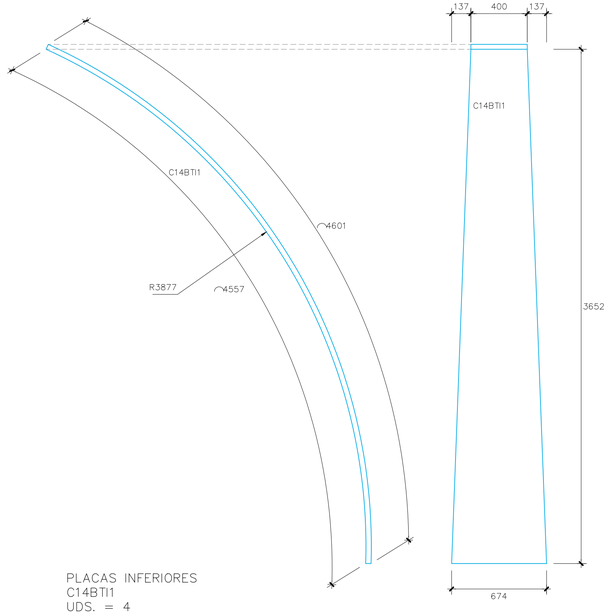
PLACAS SUPERIORES
C14BTS2
UDS. = 4
ESPESOR = 1 ½"



PLACAS SUPERIORES
C14BTS1
UDS. = 4
ESPESOR = 1 ½"

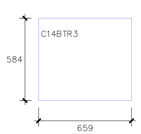


PLACAS SUPERIORES
C14BTS3
UDS. = 4
ESPESOR = 1 ½"

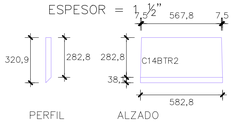


PLACAS INFERIORES
C14BTI1
UDS. = 4
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO

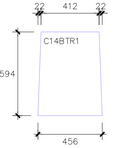


RIGIDIZADORES
C14BTR3
UDS. = 4
ESPESOR = 1 ½"



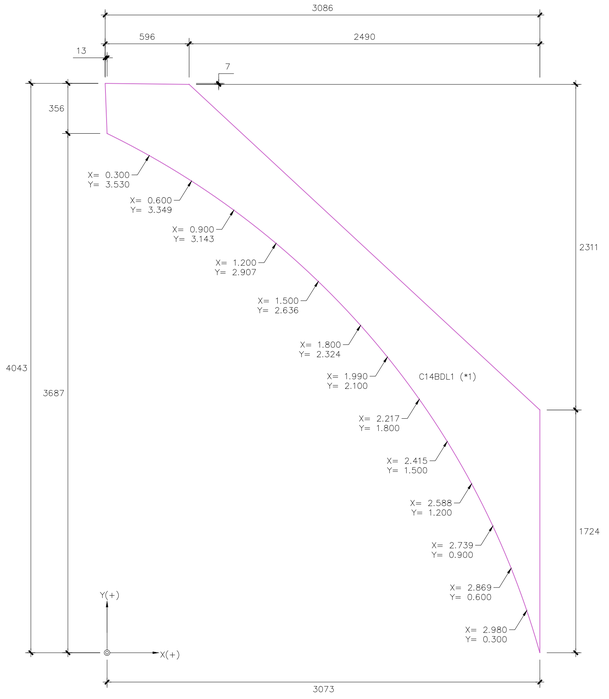
PERFIL ALZADO

RIGIDIZADORES
C14BTR2
UDS. = 4
ESPESOR = 1 ½"

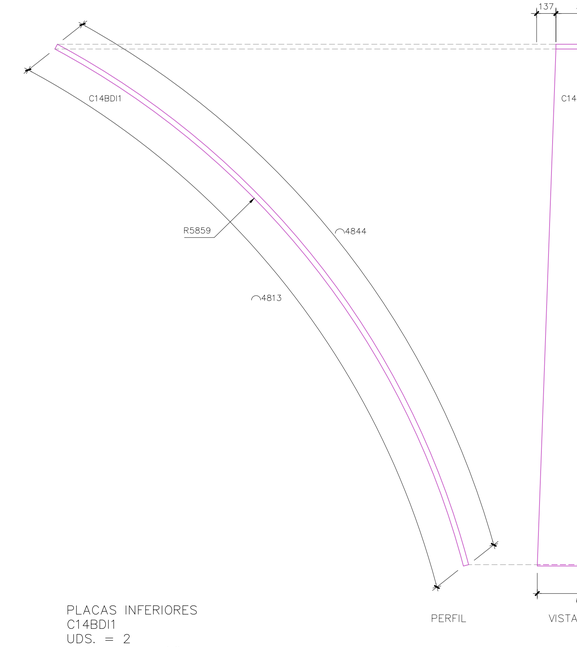


RIGIDIZADORES
C14BTR1
UDS. = 4
ESPESOR = 1 ½"

COLUMNA 14
DESPIECE DE BRAZOS TRANSVERSALES
ESCALA 1:20

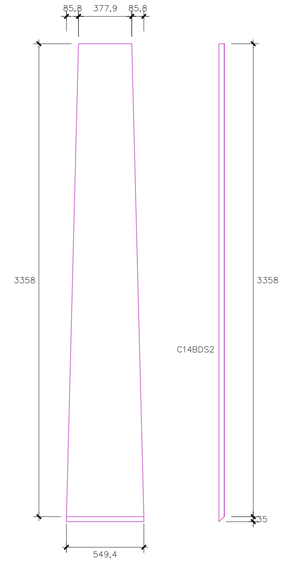


PLACAS
LATERALES
C14BDL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



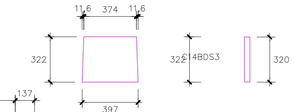
PLACAS INFERIORES
C14BDI1
UDS. = 2
ESPESOR = 1 ½"

PERFIL VISTA EN ALZADO



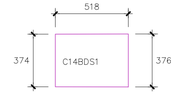
VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C14BDS2
UDS. = 2
ESPESOR = 1 ½"

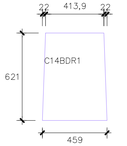


VISTA EN ALZADO PERFIL

PLACAS SUPERIORES
C14BDS3
UDS. = 2
ESPESOR = 1 ½"



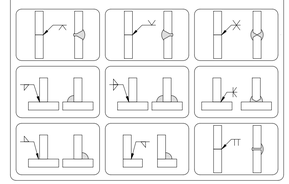
PLACAS SUPERIORES
C14BDS1
UDS. = 2
ESPESOR = 1 ½"



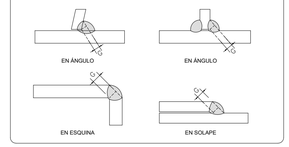
PLACAS
RIGIDIZADORAS
C14BDR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 14
DESPIECE DE BRAZO DORSAL
ESCALA 1:20

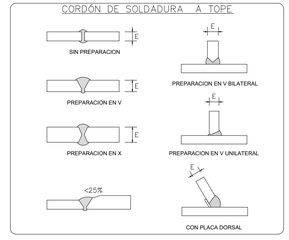
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS COLUMNA 14

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1496

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-1496

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 14. DESPIECE (I)

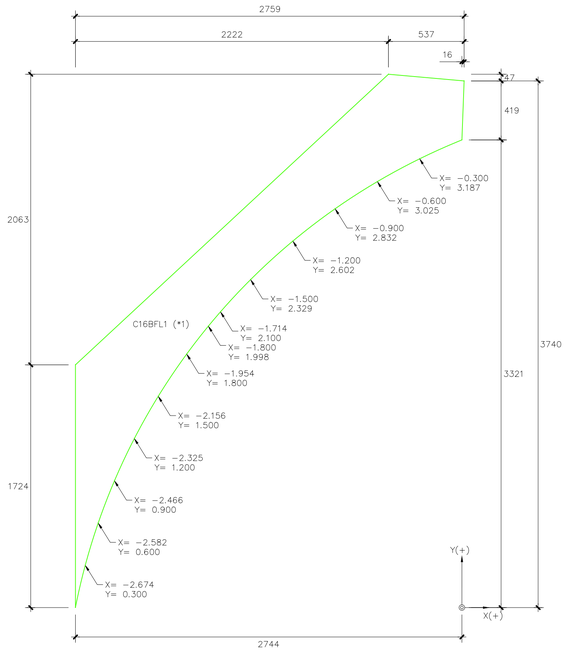
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0051-00252-P-00**

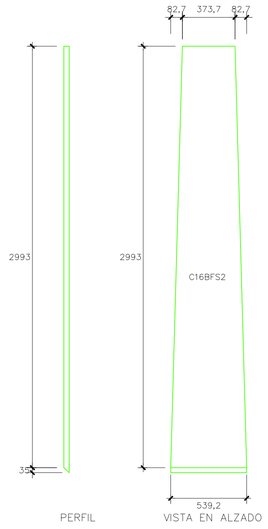
ESCALA GRÁFICA: 0.2 0.6 1

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

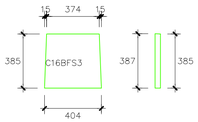
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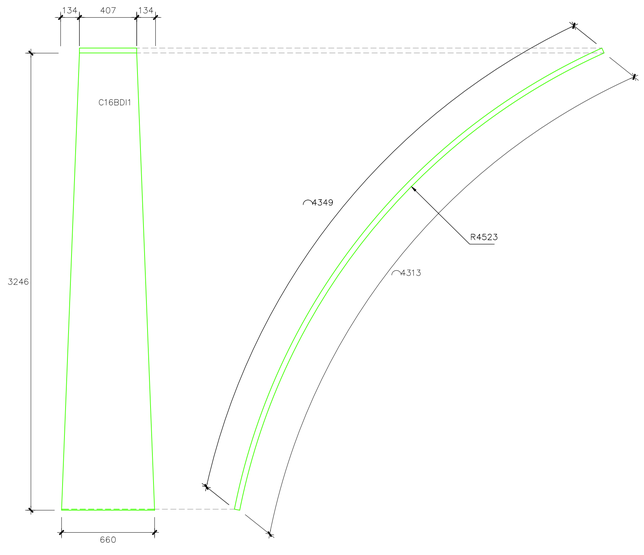
PLACAS
LATERALES
C16BFL1 (*1)
UDS. = 4
ESPESOR = 1 ½"



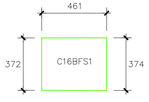
PLACAS SUPERIORES
C16BFS2
UDS. = 2
ESPESOR = 1 ½"



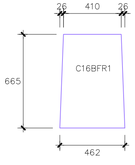
PLACAS SUPERIORES
C16BFS3
UDS. = 2
ESPESOR = 1 ½"



PLACAS INFERIORES
C16BFI1
UDS. = 2
ESPESOR = 1 ½"

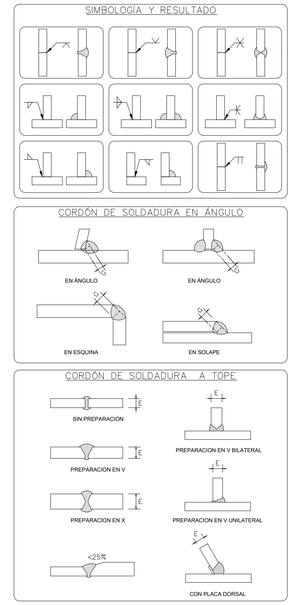


PLACAS SUPERIORES
C16BFS1
UDS. = 2
ESPESOR = 1 ½"



PLACAS
RIGIDIZADORAS
C16BFR1
UDS. = 2
ESPESOR = 1 ½"

COLUMNA 16
DESPIECE DE BRAZO FRONTAL
ESCALA 1:20



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

(*1) PLACAS LATERALES DE BRAZOS BTL1 – BDL1 – BFL1

– PARA EL MONTAJE DE LOS BRAZOS, LA ÚLTIMA PLACA EN COLOCAR SERÁ UNA DE LAS PLACAS LATERALES.
– EN ESTA ÚLTIMA PLACA DEBERÁN EJECUTARSE RANURAS CORRESPONDIENTES A SU ENCUENTRO CON LAS PLACAS RIGIDIZADORAS (BTR – BDR – BFR), PARA PERMITIR LA SOLDADURA DE LA PLACA RIGIDIZADORA A LA PLACA DE CIERRE DEL BRAZO.

(*2) PIEZAS DE REMATE ESTÉTICO SUPERIOR DE LAS RAMAS

– LAS PIEZAS SUPERIORES DE REMATE NO TIENEN FUNCIÓN ESTRUCTURAL.
– SE DISPONEN PARA MEJORAR LA ESTÉTICA DEL ACABADO, CONSIGUIENDO QUE LAS RAMAS DE LA COLUMNA SE INTEGREN EN TANGENCIA A LA CARA INFERIOR DEL TABLERO.
– LAS DIMENSIONES INDICADAS EN ESTE PLANO NO RESPONDEN A LAS DIMENSIONES REALES DE LAS PIEZAS, SINO A SUS DIMENSIONES TEÓRICAS (CRITERIO GEOMÉTRICO DE ENCAJE). LAS DIMENSIONES REALES DE LAS PIEZAS DE REMATE, ASÍ COMO EL CORRESPONDIENTE DESPIECE DE SUS PLACAS, SE DEFINIRÁN EN UN PLANO INDEPENDIENTE, PARTICULARIZANDO LA SOLUCIÓN PARA CADA COLUMNA.
– ESTAS PIEZAS DE REMATE SE SOLDARÁN EN OBRA, UNA VEZ SE HAYAN REALIZADO TODAS LAS UNIONES SOLDADAS ENTRE LAS PLACAS ESTRUCTURALES DEL TABLERO Y DE LA COLUMNA.

UNIDADES = 2 COLUMNAS
COLUMNA 16

– EL DESPIECE DE PLACAS ES IDÉNTICO PARA AMBAS COLUMNAS.
– LAS UNIDADES DE PLACAS INDICADAS EN EL DESPIECE SE CORRESPONDEN CON LA CANTIDAD NECESARIA PARA LA CONSTRUCCIÓN DE AMBAS COLUMNAS.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

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DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
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DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0495

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
COLUMNA 16. DESPIECE (II)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

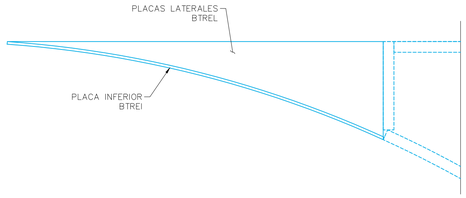
PLANO No.: **DGOT-20-EST-III-0058-00259-P-00**

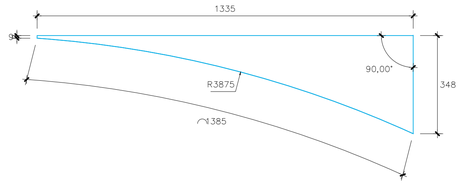
ESCALA GRÁFICA: 0 0.5 1

CO-EJECUTA	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ	

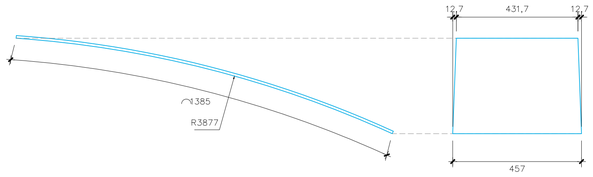
MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0058-00259-P-00



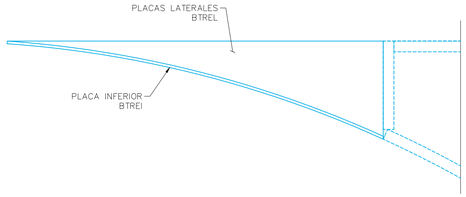


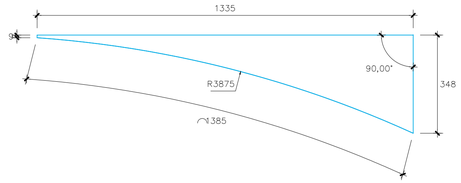
PLACAS LATERALES
C03BTREL
UDS. = 4
ESPESOR = 3/8"



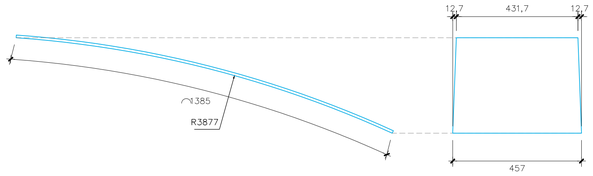
PLACA INFERIOR
C03BTREI
UDS. = 2
ESPESOR = 3/8"

COLUMNA 3
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10



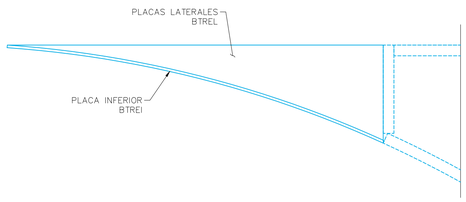


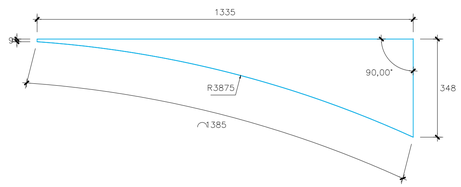
PLACAS LATERALES
C04BTREL
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ESPESOR = 3/8"



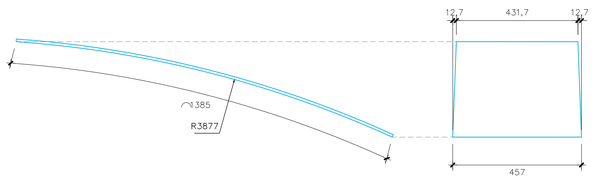
PLACA INFERIOR
C04BTREI
UDS. = 2
ESPESOR = 3/8"

COLUMNA 4
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10





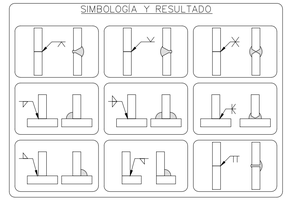
PLACAS LATERALES
C05BTREL
UDS. = 4
ESPESOR = 3/8"



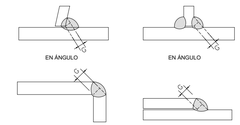
PLACA INFERIOR
C05BTREI
UDS. = 2
ESPESOR = 3/8"

COLUMNA 5
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10

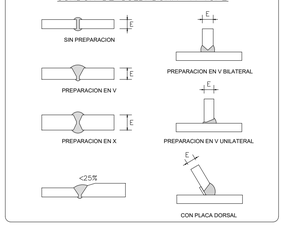
SIMBOLOGÍA Y RESULTADO

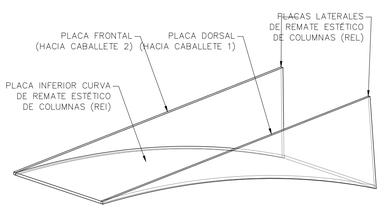


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SANCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE-0885

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNAS 3, 4 Y 5. DESPIECE

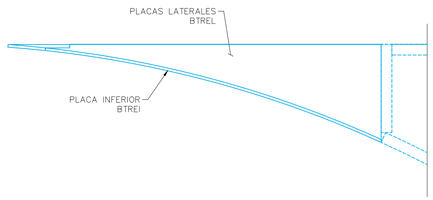
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

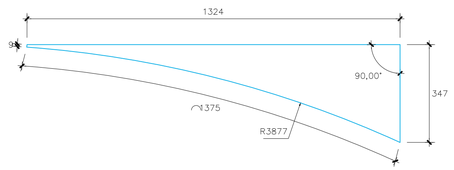
PLANO No. **DGOT-20-EST-III-0061-00262-P-00**

ESCALA GRÁFICA 0.1 0.3 0.5 1

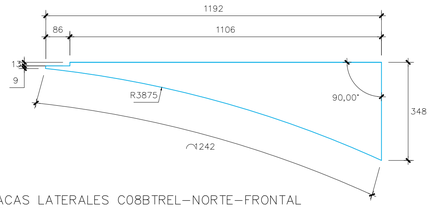
REVISÓ	FECHA	DEPTO	NOMBRE	FIRMA	MOD. 1:10
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARQS. IRANCID CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		DSC.
					ACOT. METROS

DGOT-20-EST-III-0061-00262-P-00

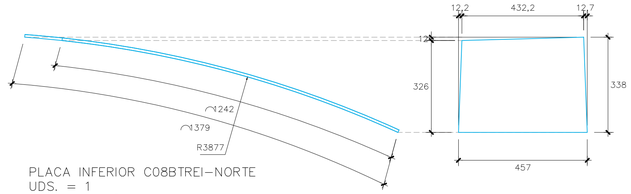




PLACAS LATERALES C08BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

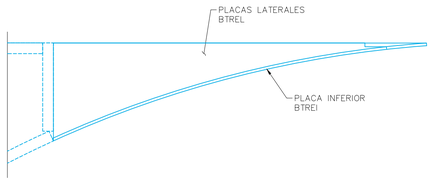


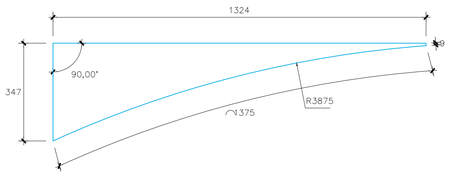
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UDS. = 1
ESPESOR = ⅜"



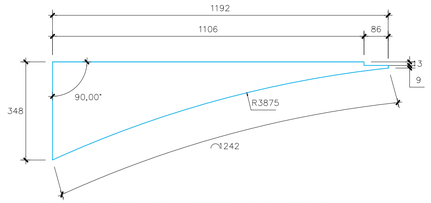
PLACA INFERIOR C08BTREI–NORTE
UDS. = 1
ESPESOR = ⅜"

COLUMNA 8 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10

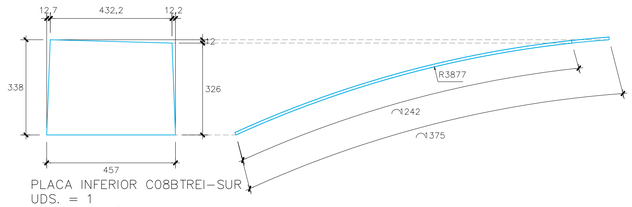




PLACAS LATERALES C08BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = ⅜"

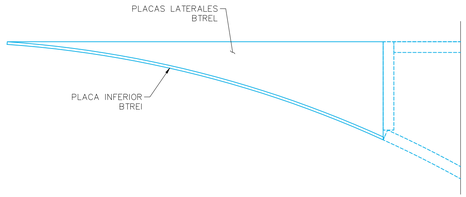


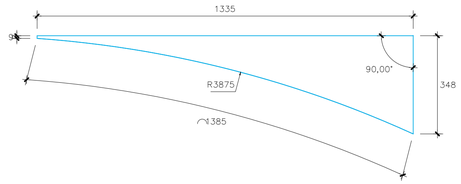
PLACAS LATERALES C08BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = ⅜"



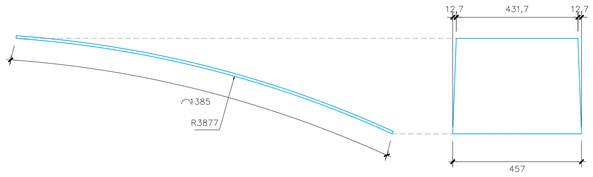
PLACA INFERIOR C08BTREI–SUR
UDS. = 1
ESPESOR = ⅜"

COLUMNA 8 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10



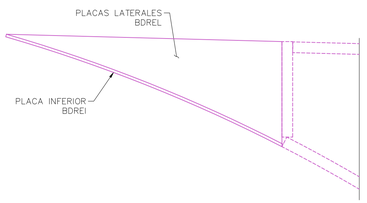


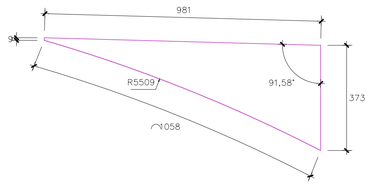
PLACAS LATERALES C08BTREL–C
UDS. = 4
ESPESOR = ⅜"



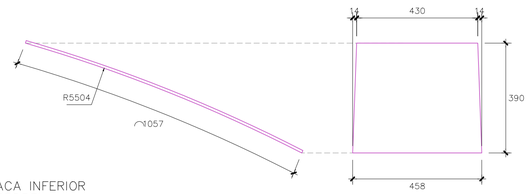
PLACA INFERIOR
C08BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 8
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



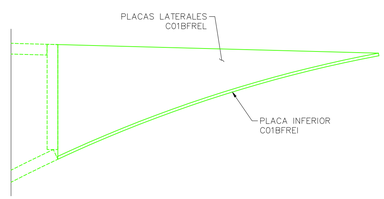


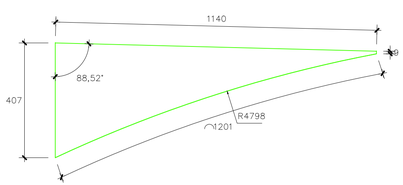
PLACAS LATERALES
C08BDREL
UDS. = 4
ESPESOR = ⅜"



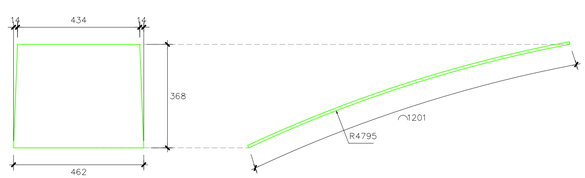
PLACA INFERIOR
C08BDREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 8
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10





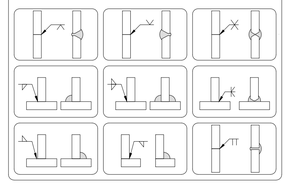
PLACAS LATERALES
C08BFREL
UDS. = 4
ESPESOR = ⅜"



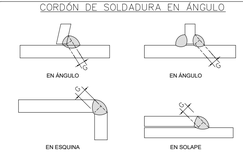
PLACA INFERIOR
C08BFREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 8
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

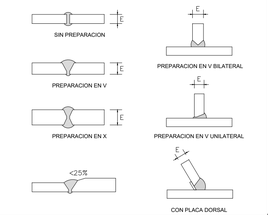
SIMBOLOGÍA Y RESULTADO

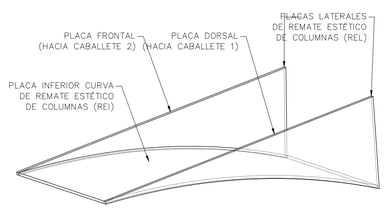


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1466

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CORRESPONSAL

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 8. DESPIECE

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

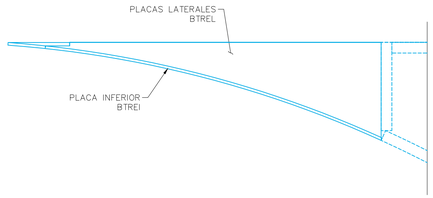
PLANO No.: **DGOT-20-EST-III-0064-00265-P-00**

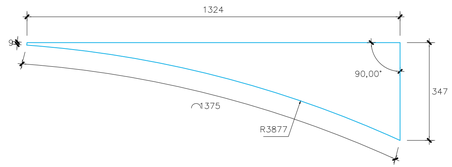
ESCALA GRÁFICA: 0.1 0.3 0.5 1

FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

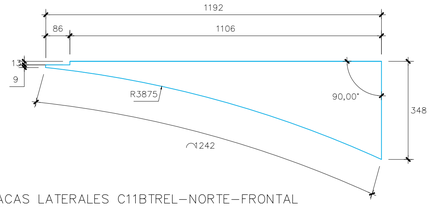
MOD. 1:10 | FECHA: JULIO 2021 | ESC: | ACOT. METROS

DGOT-20-EST-III-0064-00265-P-00

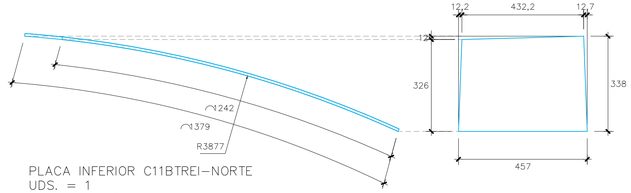




PLACAS LATERALES C11BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

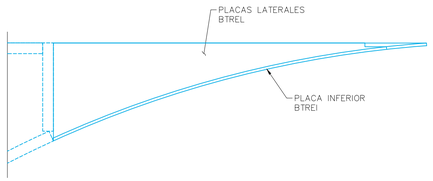


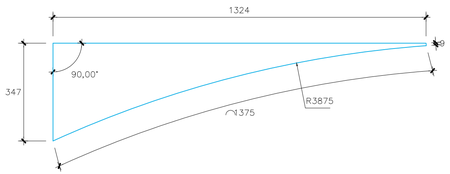
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UDS. = 1
ESPESOR = ⅜"



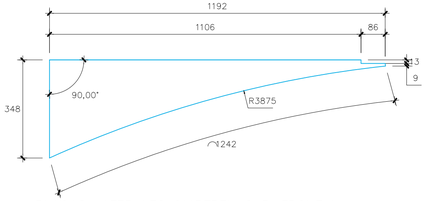
PLACA INFERIOR C11BTREI–NORTE
UDS. = 1
ESPESOR = ⅜"

COLUMNA 11 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10

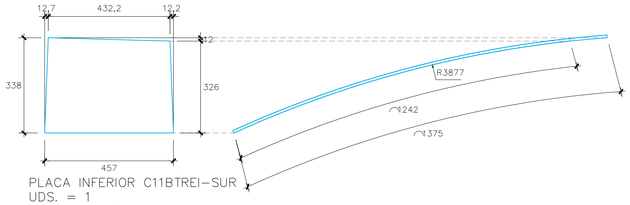




PLACAS LATERALES C11BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = ⅜"

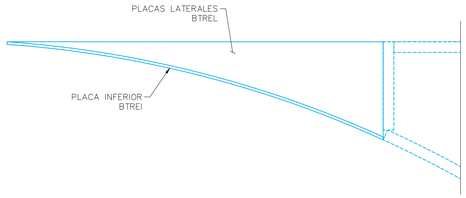


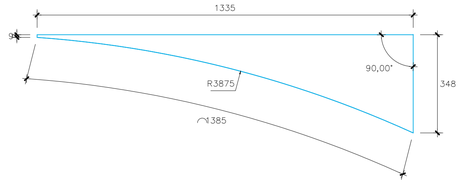
PLACAS LATERALES C11BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = ⅜"



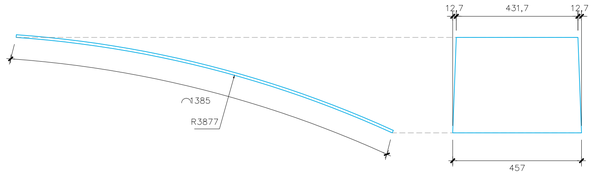
PLACA INFERIOR C11BTREI–SUR
UDS. = 1
ESPESOR = ⅜"

COLUMNA 11 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10



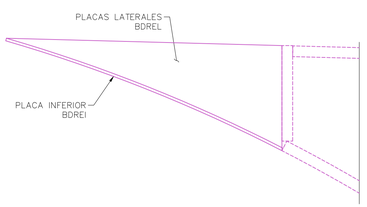


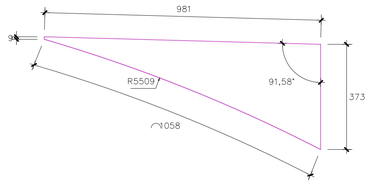
PLACAS LATERALES C11BTREL–C
UDS. = 4
ESPESOR = ⅜"



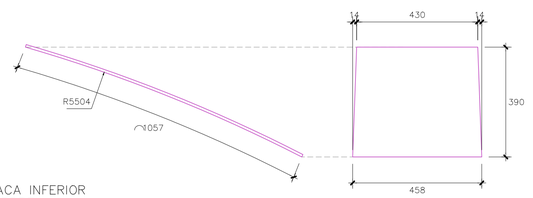
PLACA INFERIOR
C11BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 11
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



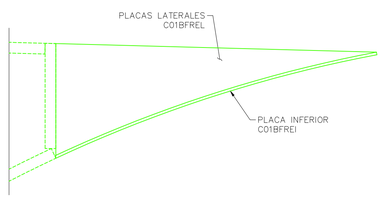


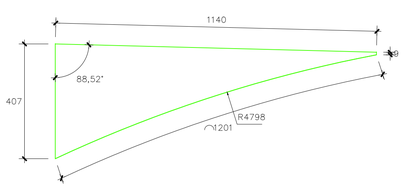
PLACAS LATERALES
C11BDREL
UDS. = 4
ESPESOR = ⅜"



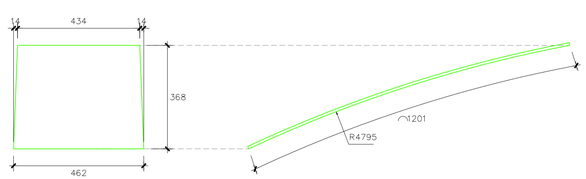
PLACA INFERIOR
C11BDREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 11
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10





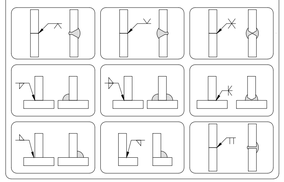
PLACAS LATERALES
C11BFREL
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ESPESOR = ⅜"



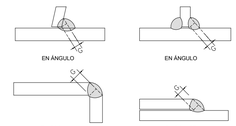
PLACA INFERIOR
C11BFREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 11
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

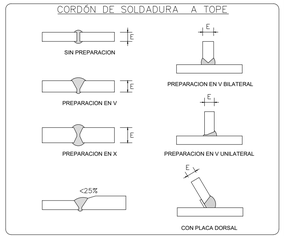
SIMBOLOGÍA Y RESULTADO

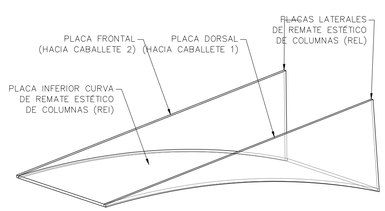


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR UNICO
FREDEL INGENIERIA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 11. DESPIECE

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

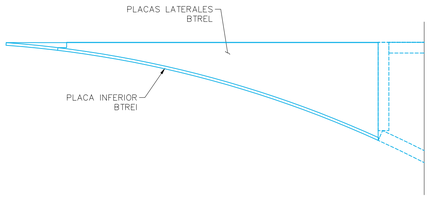
PLANO No:
DGOT-20-EST-III-0066-00267-P-00

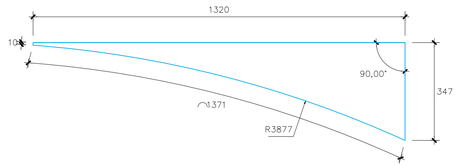
ESCALA GRÁFICA 0 0.3 0.6 1

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ	

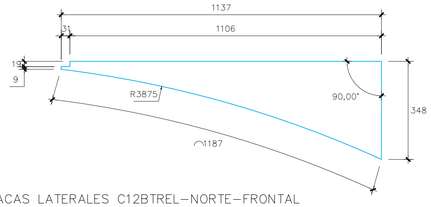
MOD: 1:10
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0066-00267-P-00

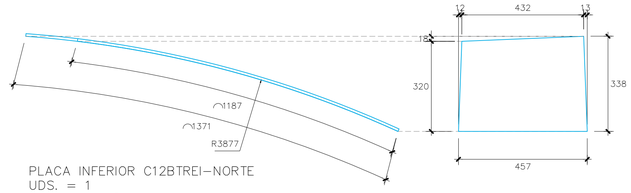




PLACAS LATERALES C12BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

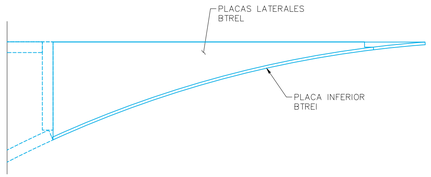


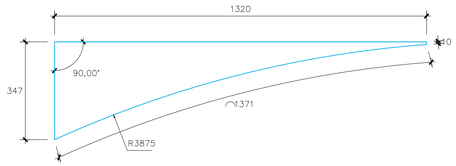
PLACAS LATERALES C12BTREL–NORTE–FRONTAL
UDS. = 1
ESPESOR = ⅜"



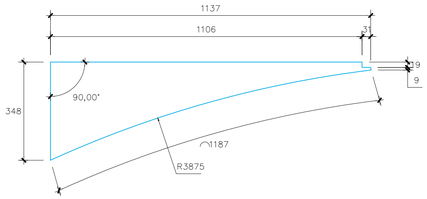
PLACA INFERIOR C12BTREI–NORTE
UDS. = 1
ESPESOR = ⅜"

COLUMNA 12 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10

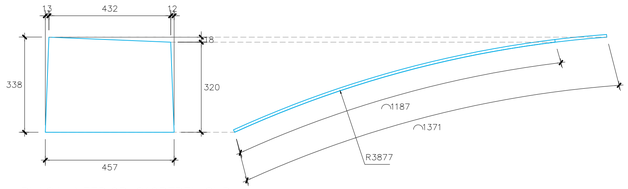




PLACAS LATERALES C12BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = ⅜"

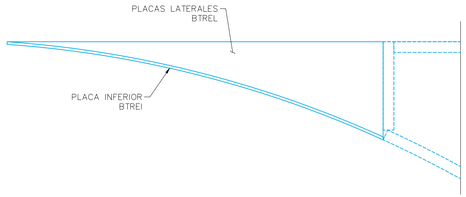


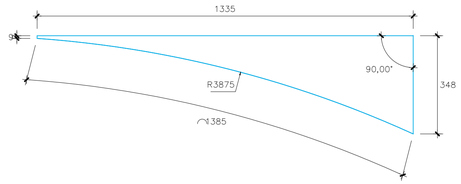
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UDS. = 1
ESPESOR = ⅜"



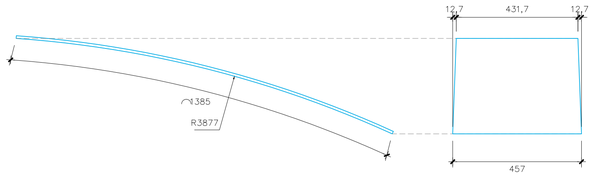
PLACA INFERIOR C12BTREI–SUR
UDS. = 1
ESPESOR = ⅜"

COLUMNA 12 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10



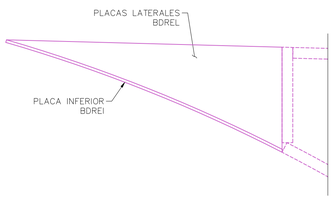


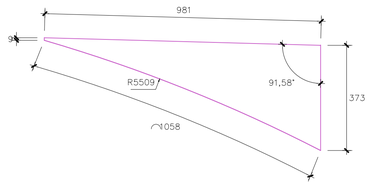
PLACAS LATERALES C12BTREL–C
UDS. = 4
ESPESOR = ⅜"



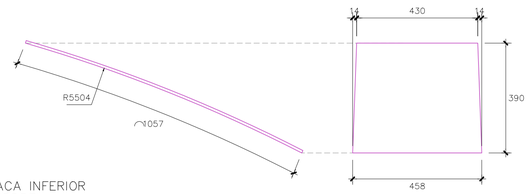
PLACA INFERIOR
C12BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 12
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



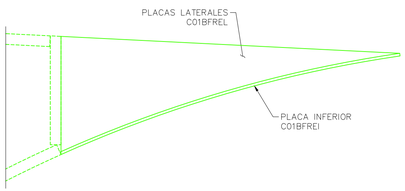


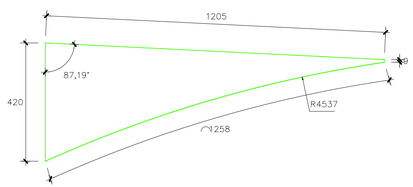
PLACAS LATERALES
C12BDREL
UDS. = 4
ESPESOR = ⅜"



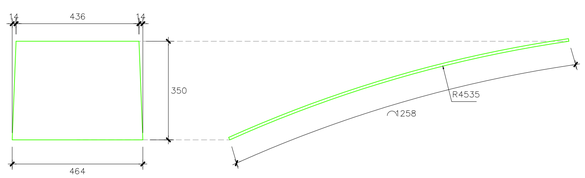
PLACA INFERIOR
C12BDREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 12
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10





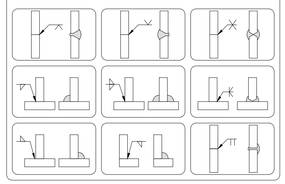
PLACAS LATERALES
C12BFREL
UDS. = 4
ESPESOR = ⅜"



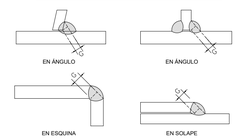
PLACA INFERIOR
C12BFREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 12
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

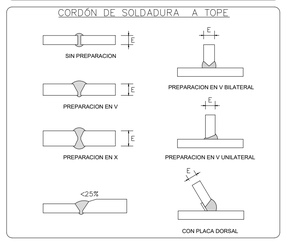
SIMBOLOGÍA Y RESULTADO

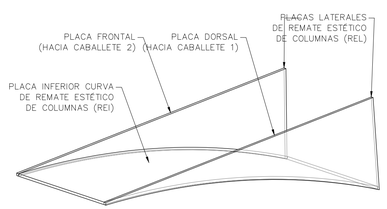


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 12. DESPIECE

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

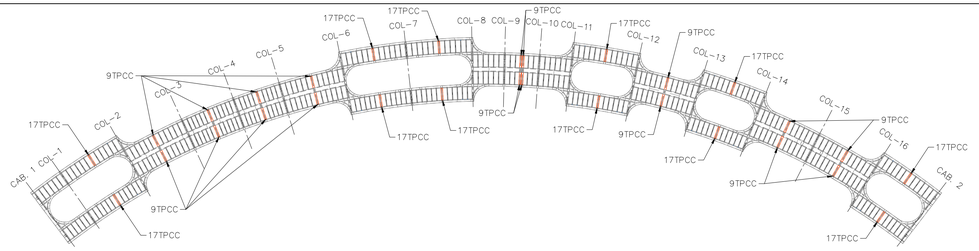
PLANO No.: DGOT-20-EST-III-0067-00268-P-00

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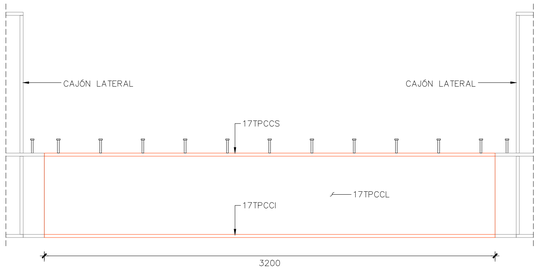
FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD. 1:10
FECHA: JULIO 2021
ESC:
ACOT. METROS

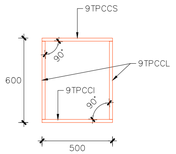
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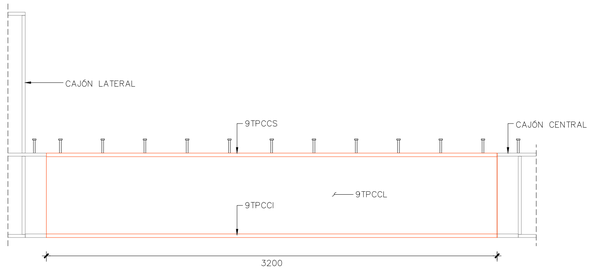
TRAVIESAS PRINCIPALES EN CENTRO DE CLARO. PLANTA GENERAL
ESCALA 1:500



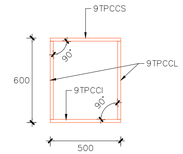
SECCIÓN TRANSVERSAL



SECCIÓN LONGITUDINAL



SECCIÓN TRANSVERSAL



SECCIÓN LONGITUDINAL



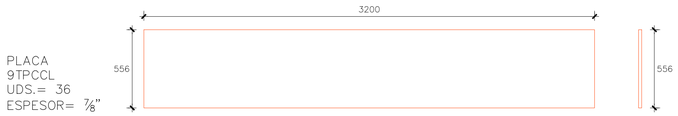




TRAVIESA PPAL. EN CENTRO DE CLARO (TAB.= 17,00m)
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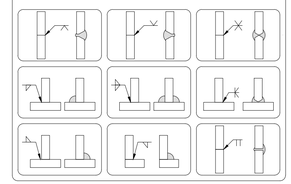




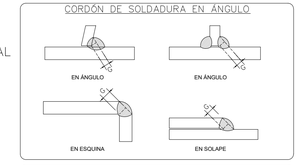


TRAVIESA PPAL. EN CENTRO DE CLARO (TAB.= 9,00m)
ESCALA 1:20

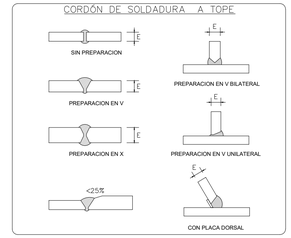
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
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ADMINISTRADOR UNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO.1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE.0985

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
TRAVIESAS PRINCIPALES (I)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

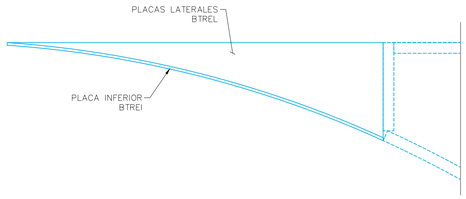
PLANO No.: **DGOT-20-EST-III-0081-00282-P-00**

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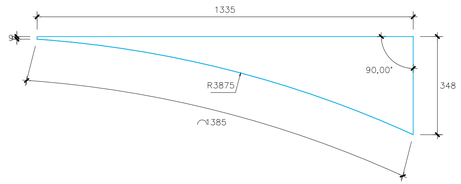
SECTOR	FECHA	DEPTO	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ	

MOD.: 1:20
FECHA: JULIO 2021
ESC.:
ACOT.: METROS

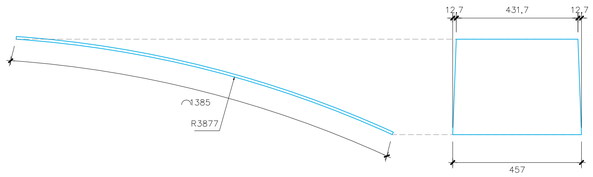
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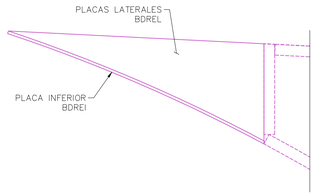
COLUMNA 15
REMATE ESTÉTICO BRAZO TRANSVERSAL
ESCALA 1:10



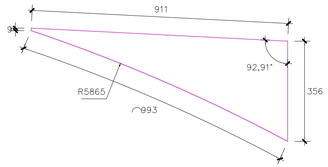
PLACAS LATERALES C15BTREL–C
UDS. = 4
ESPESOR = ⅜"



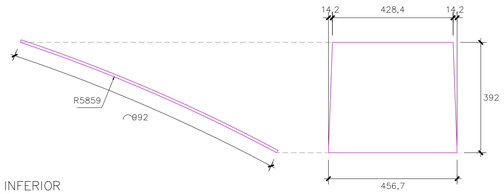
PLACA INFERIOR
C15BTREI–C
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ESPESOR = ⅜"



COLUMNA 15
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10



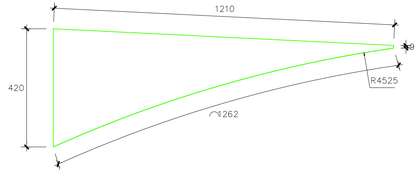
PLACAS LATERALES
C15BDREL
UDS. = 4
ESPESOR = ⅜"



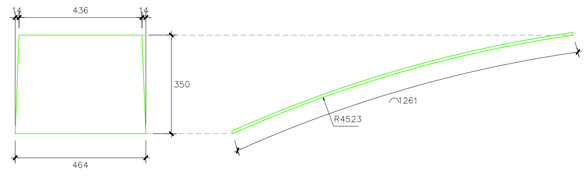
PLACA INFERIOR
C15BDREI
UDS. = 2
ESPESOR = ⅜"



COLUMNA 15
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

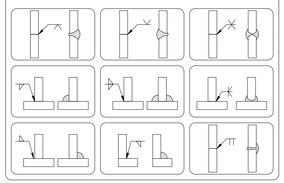


PLACAS LATERALES
C15BFREL
UDS. = 4
ESPESOR = ⅜"

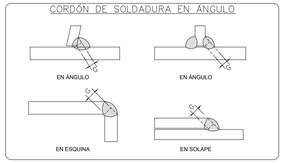


PLACA INFERIOR
C15BFREI
UDS. = 2
ESPESOR = ⅜"

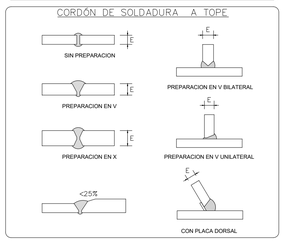
SIMBOLOGIA Y RESULTADO

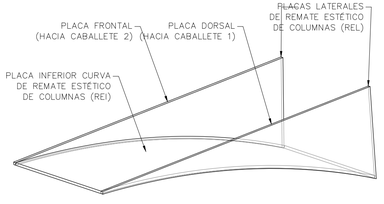


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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PLANOS DE REFERENCIA

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NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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ADMINISTRADOR ÚNICO
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0295

APROBÓ:
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REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
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TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTETICOS SUPERIORES
COLUMNA 15. DESPIECE

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

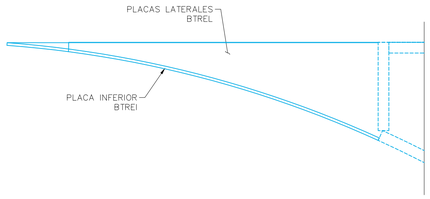
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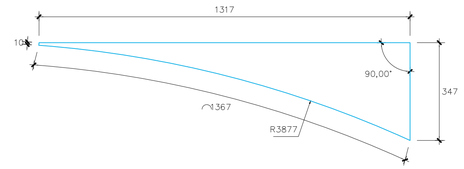
ESCALA GRÁFICA: 0 0.1 0.3 0.5 1

DETALLE	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INCIENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ	

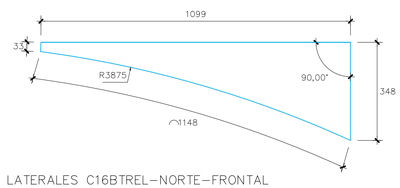
MOD: 1:10
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0070-00271-P-00

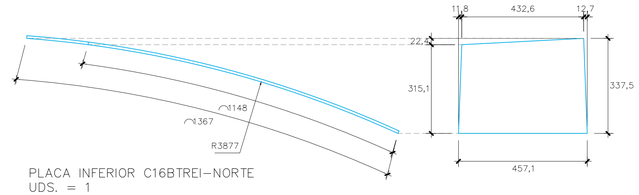




PLACAS LATERALES C16BTREL–NORTE–DORSAL
UDS. = 1
ESPESOR = ⅜"

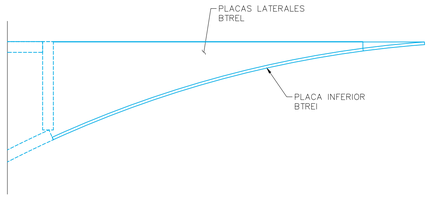


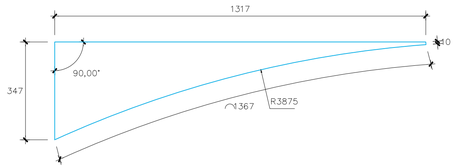
PLACAS LATERALES C16BTREL–NORTE–FRONTAL
UDS. = 1
ESPESOR = ⅜"



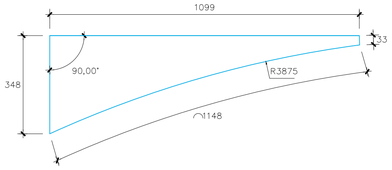
PLACA INFERIOR C16BTREI–NORTE
UDS. = 1
ESPESOR = ⅜"

COLUMNA 16 NORTE
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10

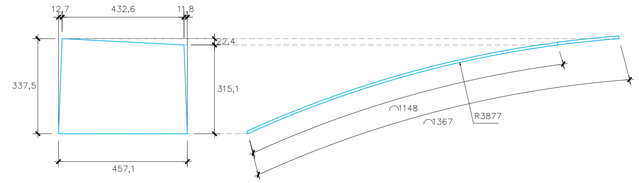




PLACAS LATERALES C16BTREL–SUR–DORSAL
UDS. = 1
ESPESOR = ⅜"

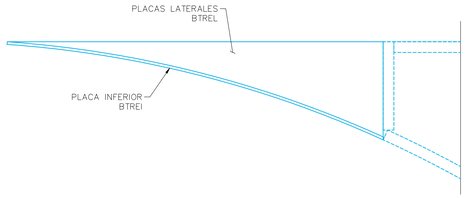


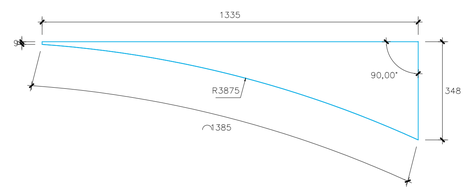
PLACAS LATERALES C16BTREL–SUR–FRONTAL
UDS. = 1
ESPESOR = ⅜"



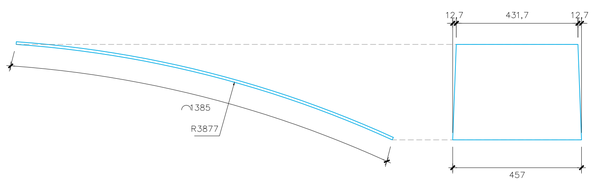
PLACA INFERIOR C16BTREI–SUR
UDS. = 1
ESPESOR = ⅜"

COLUMNA 16 SUR
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA EXTERIOR DE PASARELA
ESCALA 1:10



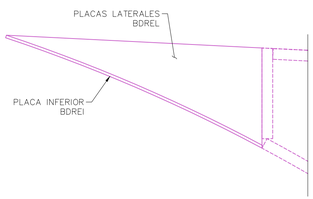


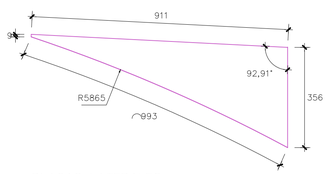
PLACAS LATERALES C16BTREL–C
UDS. = 4
ESPESOR = ⅜"



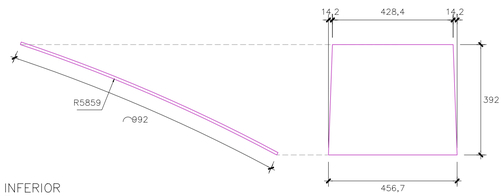
PLACA INFERIOR
C16BTREI–C
UDS. = 2
ESPESOR = ⅜"

COLUMNA 16
REMATE ESTÉTICO BRAZO TRANSVERSAL HACIA CENTRO DE CALZADA
ESCALA 1:10



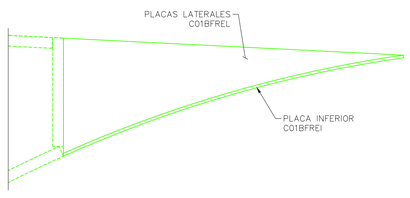


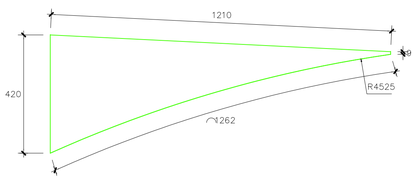
PLACAS LATERALES
C16BDREL
UDS. = 4
ESPESOR = ⅜"



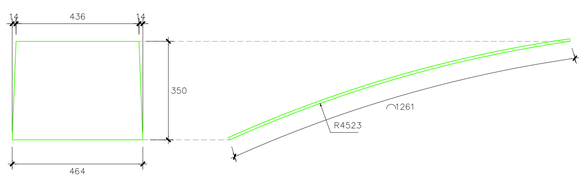
PLACA INFERIOR
C16BDREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 16
REMATE ESTÉTICO BRAZO DORSAL
ESCALA 1:10





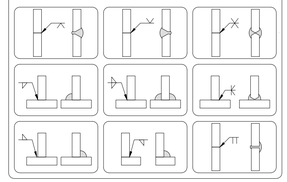
PLACAS LATERALES
C16BFREL
UDS. = 4
ESPESOR = ⅜"



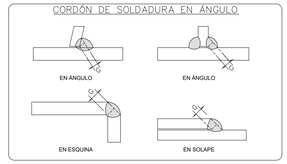
PLACA INFERIOR
C16BFREI
UDS. = 2
ESPESOR = ⅜"

COLUMNA 16
REMATE ESTÉTICO BRAZO FRONTAL
ESCALA 1:10

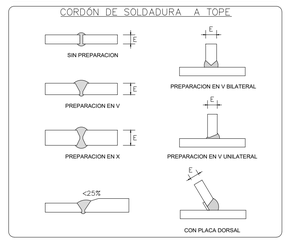
SIMBOLOGÍA Y RESULTADO

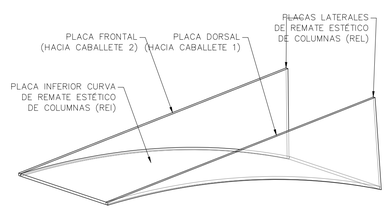


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





REMATE ESTÉTICO SUPERIOR DE COLUMN
ESQUEMA
SIN ESCALA

REMATES ESTÉTICOS. NOTAS

– AL SOLDAR LA PLACA CURVA DEL REMATE ESTÉTICO CON LAS PLACAS INFERIORES DE TABLERO, SE PROCURARÁ REALIZAR DE MODO QUE LA GEOMETRÍA DE SOLDADURA SUAVICE LA TRANSICIÓN ENTRE COLUMNAS Y TABLERO.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

PREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
PREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CVE 14245

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CVE 14245

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
COLUMNAS METÁLICAS
REMATES ESTÉTICOS SUPERIORES
COLUMNA 16. DESPIECE

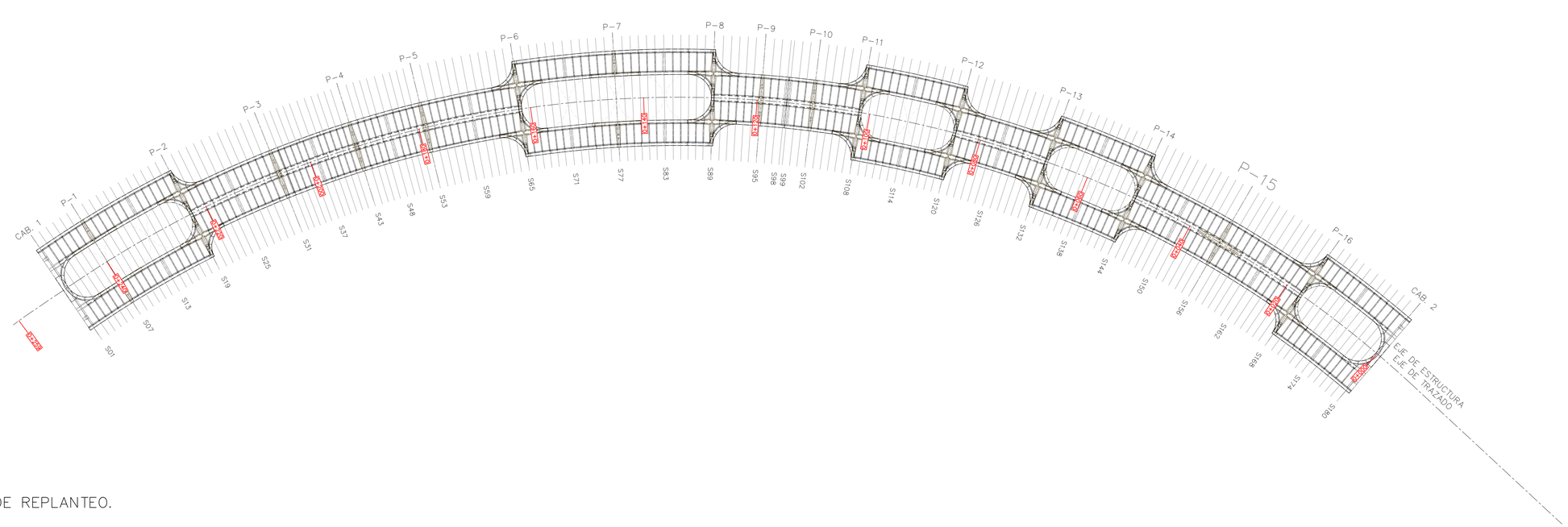
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0071-00272-P-00

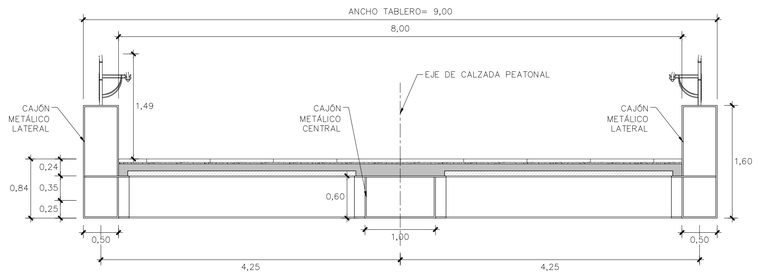
ESCALA GRÁFICA: 0 0.1 0.3 0.5 1

ESTUDIO	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:10
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ESC.
					ACOT. METROS

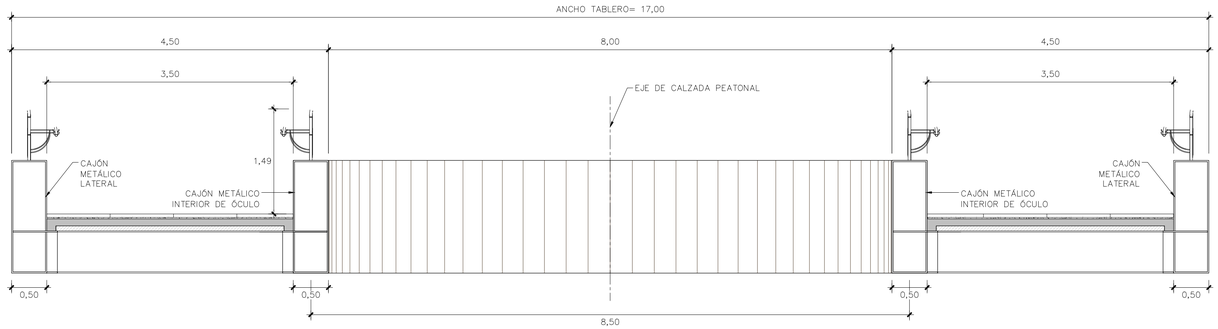
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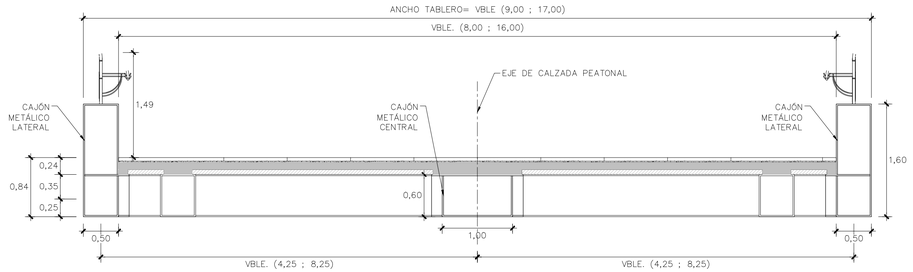
SECCIONES DE REPLANTEO.
PLANTA
ESCALA 1:400



SECCIÓN CORRESPONDIENTE A CLARO TIPO
ESCALA 1:40



SECCIÓN CORRESPONDIENTE A TABLERO EN ÓCULO
ESCALA 1:40



SECCIÓN CORRESPONDIENTE A ZONA DE TRANSICIÓN
ESCALA 1:40

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
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ADMINISTRADOR ÚNICO
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CPD-1409

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CPD-2995

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO
GEOMETRÍA Y REPLANTEO (I)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0072-00273-P-00

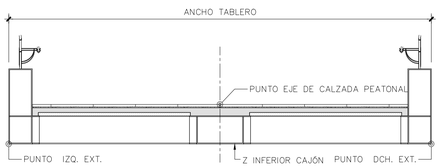
ESCALA GRÁFICA: 0 4 8 12 16

CTRLEC	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:40
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ		ESC.
					ACOT. METROS

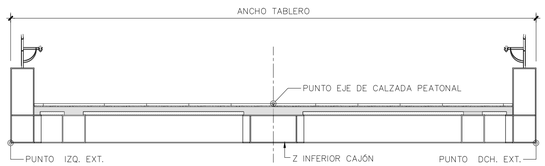
DGOT-20-EST-III-0072-00273-P-00

SECCIÓN	P.K	ANCHO TABLERO	PUNTOS DE REPLANTEO											Z INF. CAJÓN
			EJE DE TABLERO			IZQ. EXT		IZQ. INT		DCH. INT.		DCH. EXT		
			X	Y	Z	X	Y	X	Y	X	Y	X	Y	
S01 (CABALLETE 1)	0+ 248.420	17.00	479 438.950	2 147 099.519	2 277.242	479 434.183	2 147 106.556	-	-	-	-	479 443.718	2 147 092.482	2 276.402
S02	0+ 246.920	17.00	479 440.192	2 147 100.361	2 277.285	479 435.424	2 147 107.398	479 438.573	2 147 102.751	479 441.831	2 147 097.941	479 444.960	2 147 093.324	2 276.445
S03	0+ 245.545	17.00	479 441.333	2 147 101.129	2 277.324	479 436.609	2 147 108.195	479 439.248	2 147 104.247	479 443.423	2 147 098.002	479 446.056	2 147 094.062	2 276.484
S04 (CENTRO DE CLARO)	0+ 244.170	17.00	479 442.478	2 147 101.889	2 277.364	479 437.806	2 147 108.989	479 440.280	2 147 105.230	479 444.677	2 147 098.547	479 447.150	2 147 094.787	2 276.524
S05	0+ 242.789	17.00	479 443.635	2 147 102.644	2 277.404	479 439.009	2 147 109.774	479 441.458	2 147 105.999	479 445.812	2 147 099.288	479 448.261	2 147 095.513	2 276.564
S06	0+ 241.420	17.00	479 444.786	2 147 103.383	2 277.443	479 440.217	2 147 110.551	479 442.636	2 147 106.756	479 446.936	2 147 100.010	479 449.355	2 147 096.216	2 276.603
S07 (COLUMNA 1)	0+ 239.920	17.00	479 446.055	2 147 104.185	2 277.487	479 441.542	2 147 111.388	479 443.932	2 147 107.575	479 448.179	2 147 100.795	479 450.567	2 147 096.981	2 276.647
S08	0+ 238.420	17.00	479 447.329	2 147 104.976	2 277.530	479 442.874	2 147 112.215	479 445.233	2 147 108.383	479 449.426	2 147 101.569	479 451.784	2 147 097.737	2 276.690
S09	0+ 237.045	17.00	479 448.503	2 147 105.692	2 277.569	479 444.100	2 147 112.964	479 446.431	2 147 109.114	479 450.574	2 147 102.271	479 452.905	2 147 098.421	2 276.729
S10	0+ 235.670	17.00	479 449.681	2 147 106.400	2 277.609	479 445.332	2 147 113.703	479 447.635	2 147 109.837	479 451.728	2 147 102.964	479 454.031	2 147 099.097	2 276.769
S11	0+ 234.295	17.00	479 450.865	2 147 107.100	2 277.649	479 446.569	2 147 114.434	479 448.843	2 147 110.551	479 452.887	2 147 103.648	479 455.162	2 147 099.765	2 276.809
S12	0+ 232.920	17.00	479 452.054	2 147 107.790	2 277.688	479 447.811	2 147 115.155	479 450.057	2 147 111.256	479 454.051	2 147 104.324	479 456.298	2 147 100.425	2 276.848
S13 (CENTRO DE CLARO)	0+ 231.420	17.00	479 453.357	2 147 108.534	2 277.731	479 449.172	2 147 115.932	479 451.388	2 147 112.016	479 455.326	2 147 105.052	479 457.542	2 147 101.136	2 276.891
S14	0+ 229.920	17.00	479 454.665	2 147 109.267	2 277.775	479 450.539	2 147 116.699	479 452.724	2 147 112.764	479 456.607	2 147 105.770	479 458.792	2 147 101.836	2 276.935
S15	0+ 228.545	17.00	479 455.870	2 147 109.930	2 277.814	479 451.798	2 147 117.391	479 453.954	2 147 113.441	479 457.786	2 147 106.419	479 459.942	2 147 102.469	2 276.974
S16	0+ 227.170	17.00	479 457.079	2 147 110.585	2 277.854	479 453.061	2 147 118.075	479 455.188	2 147 114.110	479 458.970	2 147 107.060	479 461.097	2 147 103.094	2 277.014
S17	0+ 225.795	17.00	479 458.293	2 147 111.230	2 277.893	479 454.330	2 147 118.750	479 456.544	2 147 114.549	479 460.047	2 147 107.903	479 462.257	2 147 103.711	2 277.053
S18	0+ 224.420	17.00	479 459.512	2 147 111.867	2 277.933	479 455.603	2 147 119.415	479 458.185	2 147 114.429	479 460.857	2 147 109.270	479 463.421	2 147 104.319	2 277.093
S19 (COLUMNA 2)	0+ 222.920	17.00	479 460.847	2 147 112.552	2 277.976	479 456.997	2 147 120.130	-	-	-	-	479 464.696	2 147 104.973	2 277.136
S20	0+ 221.420	11.27	479 462.187	2 147 113.226	2 278.020	479 459.680	2 147 118.260	-	-	-	-	479 464.703	2 147 108.173	2 277.180
S21	0+ 220.045	9.53	479 463.420	2 147 113.834	2 278.059	479 461.333	2 147 118.101	-	-	-	-	479 465.519	2 147 109.541	2 277.219
S22	0+ 218.670	9.00	479 464.657	2 147 114.434	2 278.099	479 462.710	2 147 118.491	-	-	-	-	479 466.605	2 147 110.377	2 277.259
S23	0+ 217.295	9.00	479 465.899	2 147 115.024	2 278.138	479 463.981	2 147 119.095	-	-	-	-	479 467.817	2 147 110.954	2 277.298
S24	0+ 215.920	9.00	479 467.145	2 147 115.606	2 278.178	479 465.256	2 147 119.691	-	-	-	-	479 469.033	2 147 111.521	2 277.338
S25 (CENTRO DE CLARO)	0+ 214.420	9.00	479 468.508	2 147 116.230	2 278.221	479 466.652	2 147 120.329	-	-	-	-	479 470.366	2 147 112.131	2 277.381
S26	0+ 212.920	9.00	479 469.878	2 147 116.843	2 278.264	479 468.054	2 147 120.957	-	-	-	-	479 471.701	2 147 112.730	2 277.424
S27	0+ 211.545	9.00	479 471.137	2 147 117.396	2 278.304	479 469.343	2 147 121.523	-	-	-	-	479 472.930	2 147 113.269	2 277.464
S28	0+ 210.170	9.00	479 472.400	2 147 117.940	2 278.344	479 470.636	2 147 122.080	-	-	-	-	479 474.164	2 147 113.800	2 277.504
S29	0+ 208.795	9.00	479 473.667	2 147 118.474	2 278.383	479 471.933	2 147 122.627	-	-	-	-	479 475.400	2 147 114.322	2 277.543
S30	0+ 207.420	9.00	479 474.937	2 147 118.999	2 278.423	479 473.233	2 147 123.164	-	-	-	-	479 476.641	2 147 114.834	2 277.583
S31 (COLUMNA 3)	0+ 205.920	9.00	479 476.327	2 147 119.562	2 278.466	479 474.657	2 147 123.740	-	-	-	-	479 477.999	2 147 115.383	2 277.626
S32	0+ 204.607	9.00	479 477.548	2 147 120.045	2 278.428	479 475.906	2 147 124.235	-	-	-	-	479 479.190	2 147 115.855	2 277.588
S33	0+ 203.451	9.00	479 478.626	2 147 120.463	2 278.395	479 477.010	2 147 124.663	-	-	-	-	479 480.242	2 147 116.264	2 277.555
S34	0+ 202.295	9.00	479 479.706	2 147 120.875	2 278.362	479 478.116	2 147 125.085	-	-	-	-	479 481.297	2 147 116.666	2 277.522
S35	0+ 201.139	9.00	479 480.789	2 147 121.281	2 278.328	479 479.224	2 147 125.500	-	-	-	-	479 482.354	2 147 117.062	2 277.488
S36	0+ 199.982	9.00	479 481.874	2 147 121.680	2 278.295	479 480.335	2 147 125.908	-	-	-	-	479 483.414	2 147 117.451	2 277.455
S37 (CENTRO DE CLARO)	0+ 198.670	9.00	479 483.109	2 147 122.124	2 278.257	479 481.596	2 147 126.362	-	-	-	-	479 484.624	2 147 117.887	2 277.417
S38	0+ 197.357	9.00	479 484.347	2 147 122.560	2 278.220	479 482.867	2 147 126.810	-	-	-	-	479 485.828	2 147 118.311	2 277.380
S39	0+ 196.201	9.00	479 485.440	2 147 122.937	2 278.186	479 483.986	2 147 127.196	-	-	-	-	479 486.895	2 147 118.679	2 277.346
S40	0+ 195.045	9.00	479 486.536	2 147 123.308	2 278.153	479 485.107	2 147 127.575	-	-	-	-	479 487.964	2 147 119.041	2 277.313
S41	0+ 193.889	9.00	479 487.633	2 147 123.672	2 278.120	479 486.230	2 147 127.947	-	-	-	-	479 489.036	2 147 119.396	2 277.280
S42	0+ 192.732	9.00	479 488.733	2 147 124.029	2 278.086	479 487.356	2 147 128.313	-	-	-	-	479 490.109	2 147 119.744	2 277.246
S43 (COLUMNA 4)	0+ 191.420	9.00	479 489.984	2 147 124.426	2 278.048	479 488.633	2 147 128.719	-	-	-	-	479 491.334	2 147 120.133	2 277.208
S44	0+ 190.032	9.00	479 491.309	2 147 124.836	2 277.987	479 489.994	2 147 129.140	-	-	-	-	479 492.625	2 147 120.533	2 277.147
S45	0+ 188.857	9.00	479 492.434	2 147 125.176	2 277.936	479 491.145	2 147 129.488	-	-	-	-	479 493.723	2 147 120.865	2 277.096
S46	0+ 187.682	9.00	479 493.562	2 147 125.506	2 277.884	479 492.299	2 147 129.829	-	-	-	-	479 494.823	2 147 121.190	2 277.044
S47	0+ 186.507	9.00	479 494.690	2 147 125.835	2 277.832	479 493.454	2 147 130.163	-	-	-	-	479 495.925	2 147 121.508	2 276.992
S48 (CENTRO DE CLARO)	0+ 185.120	9.00	479 496.025	2 147 126.211	2 277.771	479 494.822	2 147 130.548	-	-	-	-	479 497.229	2 147 121.875	2 276.931
S49	0+ 183.732	9.00	479 497.364	2 147 126.578	2 277.710	479 496.192	2 147 130.922	-	-	-	-	479 498.535	2 147 122.233	2 276.870
S50	0+ 182.557	9.00	479 498.499	2 147 126.880	2 277.659	479 497.354	2 147 131.232	-	-	-	-	479 499.644	2 147 122.528	2 276.819
S51	0+ 181.382	9.00	479 499.636	2 147 127.176	2 277.607	479 498.518	2 147 131.535	-	-	-	-	479 500.754	2 147 122.817	2 276.767
S52	0+ 180.207	9.00	479 500.775	2 147 127.464	2 277.555	479 499.684	2 147 131.830	-	-	-	-	479 501.866	2 147 123.098	2 276.715
S53 (COLUMNA 5)	0+ 178.819	9.00	479 502.123	2 147 127.796	2 277.494	479 501.058	2 147 132.168	-	-	-	-	479 503.182	2 147 123.422	2 276.654
S54	0+ 177.320	9.00	479 503.582	2 147 128.143	2 277.428	479 502.557	2 147 132.525	-	-	-	-	479 504.606	2 147 123.761	2 276.588
S55	0+ 175.945	9.00	479 504.922	2 147 128.451	2 277.368	479 503.929	2 147 132.840	-	-	-	-	479 505.914	2 147 124.062	2 276.528
S56	0+ 174.570	9.00	479 506.264	2 147 128.749	2 277.307	479 505.303	2 147 133.146	-	-	-	-	479 507.225	2 147 124.353	2 276.467
S57	0+ 173.195	9.00	479 507.608	2 147 129.038	2 277.247	479 506.679	2 147 133.441	-	-	-	-	479 508.537	2 147 124.635	2 276.407
S58	0+ 171.820	9.00	479 508.955	2 147 129.317	2 277.186	479 508.058	2 147 133.727	-	-	-	-	479 509.852	2 147 124.907	2 276.346
S59 (CENTRO DE CLARO)	0+ 170.320	9.00	479 510.425	2 147 129.610	2 277.120	479 509.567	2 147 134.028	-	-	-	-	479 511.284	2 147 125.193	2 276.280
S60	0+ 168.820	9.00	479 511.899	2 147 129.892	2 277.054	479 511.072	2 147 134.315	-	-	-	-	479 512.726	2 147 125.469	2 276.214
S61	0+ 167.445	9.00	479 513.252	2 147 130.135	2 276.994	479 512.456	2 147 134.569	-	-	-	-	479 514.047	2 147 125.711	2 276.154
S62	0+ 166.070	9.00	479 514.606	2 147 130.378	2 276.933	479 513.843	2 147 134.813	-	-	-	-	479 515.369	2 147 125.943	2 276.093
S63	0+ 164.695	9.53	479 515.962	2 147 130.606	2 276.873	479 515.190	2 147 135.293	-	-	-	-	479 516.738	2 147 125.890	2 276.033
S64	0+ 163.320	11.27	479 517.319	2 147 130.824	2 276.812	479 516.446	2 147 136.380	-	-	-	-	479 518.196	2 147 125.249	2 275.972
S65 (COLUMNA 6)	0+ 161.820	17.00	479 518.802	2 147 131.051	2 276.747	479 517.549	2 147 139.458	-	-	-	-	479 520.055	2 147 122.644	2 275.907
S66	0+ 160.320	17.00	479 520.286	2 147 131.267	2 276.707	479 519.100	2 147 139.683	479 519.884	2 147 134.123	479 520.695	2 147 128.371	479 521.473	2 147 122.850	2 275.867
S67	0+ 158.945	17.00	479 521.649	2 147 131.454	2 276.670	479 520.523	2 147 139.879	479 521.152	2 147 135.172	479 522.147	2 147 127.726	479 522.774	2 147 123.029	2 275.830
S68	0+ 157.570	17.00	479 523.012	2 147 131.631	2 276.634	479 521.948	2 147 140.064	479 522.511	2 147 135.599	479 523.513	2 147 127.662	479 524.077	2 147 123.198	2 275.794
S69	0+ 156.195	17.00	479 524.377	2 147 131.798	2 276.597	479 523.373	2 147 140.239	479 523.905	2 147 135.770	479 524.849	2 147 127.826	479 525.381	2 147 123.358	2 275.757
S70	0+ 154.820	17.00	479 525.743	2 147 131.956	2 276.560	479 524.801	2 147 140.403	479 525.300	2 147 135.931	479 526.186	2 147 127.980	479 526.685	2 147 123.508	2 275.720
S71 (CENTRO DE CLARO)	0+ 153.320	17.00	479 527.234	2 147 132.116	2 276.520	479 526.359	2 147 140.571	479 526.822	2 147 136.095	479 527.646	2 147 128.137	479 528.110	2 147 123.661	2 275.680
S72	0+ 151.820	17.00	479 528.727	2 147 132.265	2 276.480	479 527.918	2 147 140.726	479 528.346	2 147 136.246	479 529.108	2 147 128.283	479 529.536	2 147 123.803	2 275.640
S73	0+ 150.445	17.00	479 530.096	2 147 132.390	2 276.444	479 529.349	2 147 140.858	479 529.745	2 147 136.375	479 530.448	2 147 128.406	479 530.844	2 147 123.923	2 275.604
S74	0+ 149.070	17.00	479 531.466	2 147 132.506	2 276.407	479 530.780	2 147 140.979	479 531.144	2 147 136.493	479 531.789	2 147 128.519	479 532.152	2 147 124.034	2 275.567
S75	0+ 147.695	17.00	479 532.837	2 147 132.612	2 276.371	479 532.213	2 147 141.089	479 532.543	2 147 136.602	479 533.131	2 147 128.623	479 533.462	2 147 124.135	2 275.531
S76	0+ 146.320	17.00	479 534.209	2 147 132.708	2 276.334	479 533.646	2 147 141.190	479 533.944	2 147 136.700	479 534.474	2 147 128.717	479 534.772	2 147 124.227	2 275.494
S77 (COLUMNA 7)	0+ 144.820	17.00	479 535.706	2 147 132.802	2 276.294	479 535.210	2 147 141.287	479 535.473	2 147 136.795	479 535.939	2 147 128.809	479 536.202	2 147 124.316	2 275.454

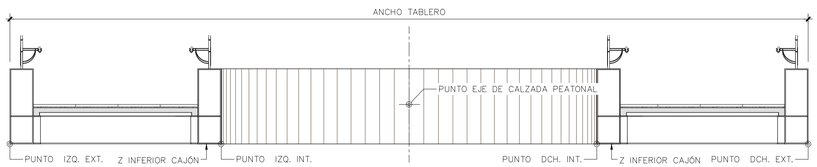
TABLA DE REPLANTEO
SIN ESCALA



SECCIÓN CORRESPONDIENTE A CLARO TIPO
ESCALA 1:60



SECCIÓN CORRESPONDIENTE A ZONA DE TRANSICIÓN
ESCALA 1:60



SECCIÓN CORRESPONDIENTE A TABLERO EN ÓCULO
ESCALA 1:60

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRIDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MACRO
CED. 1455

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED.2985

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO
GEOMETRÍA Y REPLANTEO (II)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

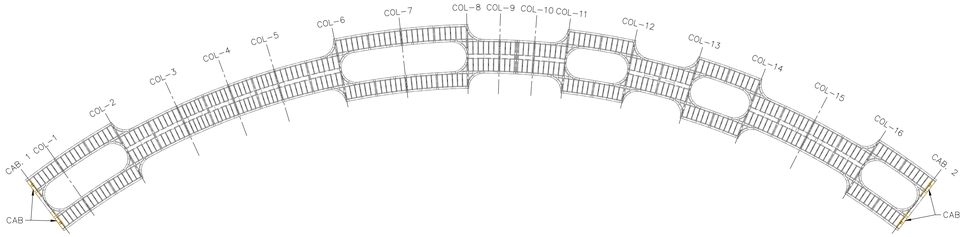
PLANO No:
DGOT-20-EST-III-0073-00274-P-00

ESCALA GRÁFICA: 0 1.0 2

REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

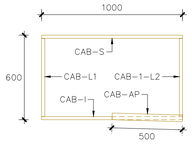
MOD.: 1:60
FECHA: JULIO 2021
ESC:
ACOT.: METROS

DGOT-20-EST-III-0073-00274-P-00



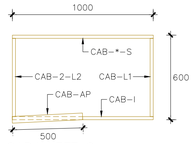
CABECEROS. PLANTA GENERAL

ESCALA 1:500

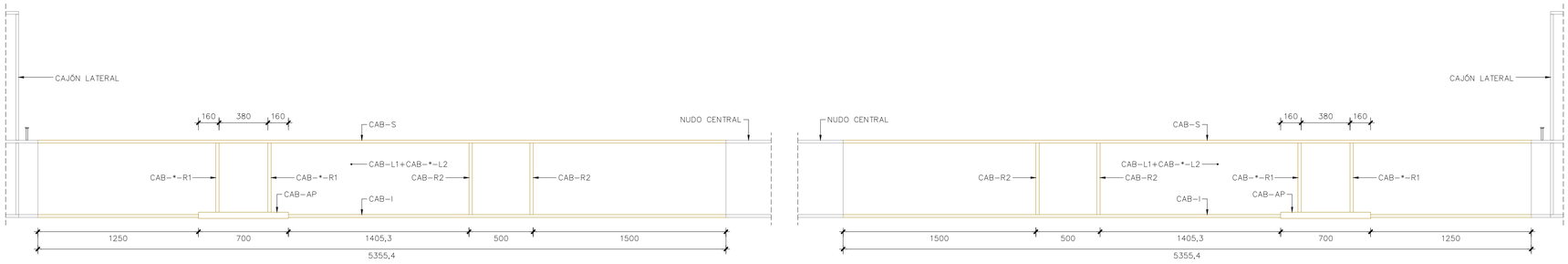


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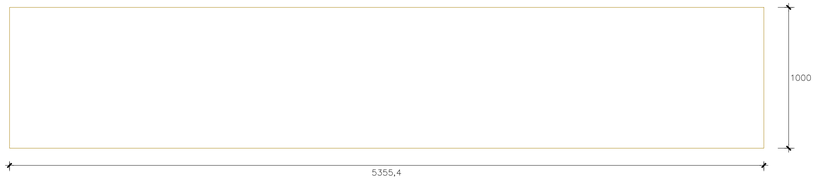
SECCIÓN LONGITUDINAL



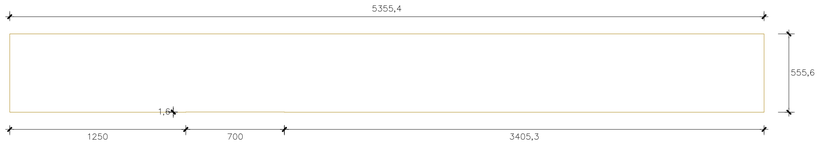
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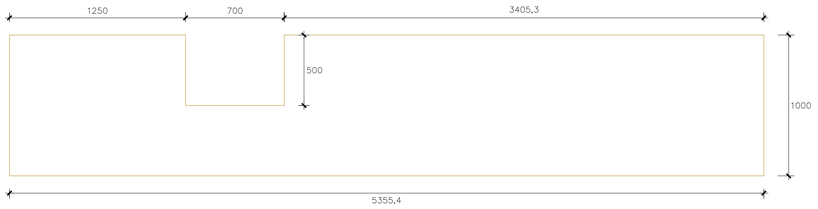
SECCIÓN TRANSVERSAL



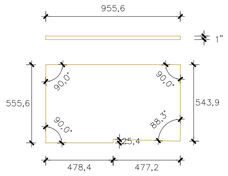
PLACA CAB-S
UDS.= 4
ESPESOR= 7/8"



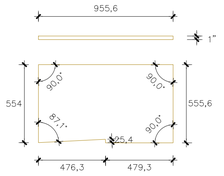
PLACA CAB-2-L2
UDS.= 2
ESPESOR= 7/8"



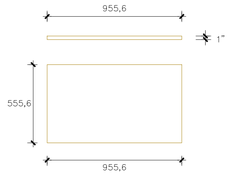
PLACA CAB-I
UDS.= 4
ESPESOR= 7/8"



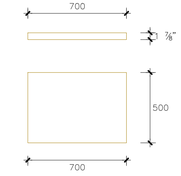
PLACA CAB-1-R1
UDS.= 4
ESPESOR= 1"



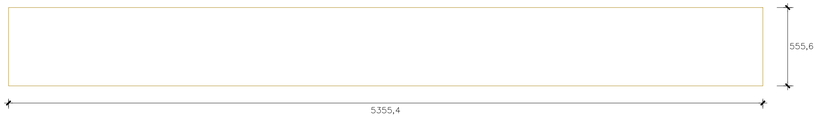
PLACA CAB-2-R1
UDS.= 4
ESPESOR= 1"



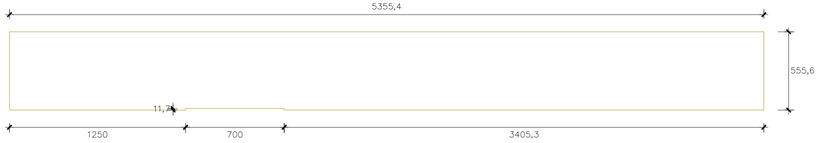
PLACA CAB-R2
UDS.= 8
ESPESOR= 1"



PLACA CAB-AP
UDS.= 4
ESPESOR= 1 7/8"



PLACA CAB-L1
UDS.= 4
ESPESOR= 7/8"

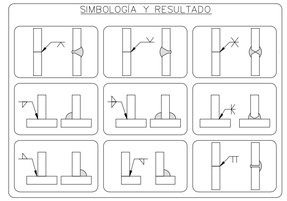


PLACA CAB-1-L2
UDS.= 2
ESPESOR= 7/8"

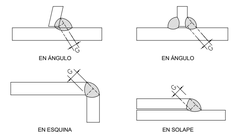
ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

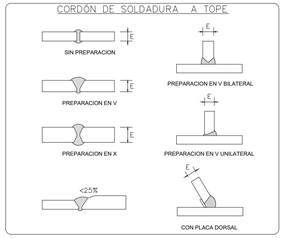
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



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2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SANCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO.1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE.0985

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA
CABECEROS

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0080-00281-P-00**

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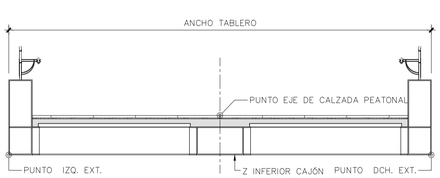
EDITAR	FECHA	DEPTO	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARQS. RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

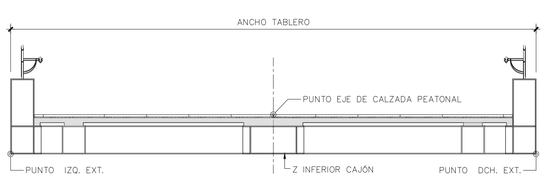
DGOT-20-EST-III-0080-00281-P-00

SECCIÓN	P.K	ANCHO TABLERO	PUNTOS DE REPLANTEO												Z INF. CAJÓN
			EJE DE TABLERO			IZQ. EXT		IZQ. INT		DCH. INT.		DCH. EXT			
			X	Y	Z	X	Y	X	Y	X	Y	X	Y		
S77 (COLUMNA 7)	0+ 144.820	17.00	479 535.706	2 147 132.802	2 276.294	479 535.210	2 147 141.287	479 535.473	2 147 136.795	479 535.939	2 147 128.809	479 536.202	2 147 124.316	2 275.454
S78	0+ 143.320	17.00	479 537.204	2 147 132.884	2 276.254	479 536.775	2 147 141.373	479 537.002	2 147 136.878	479 537.406	2 147 128.889	479 537.633	2 147 124.394	2 275.414
S79	0+ 141.945	17.00	479 538.577	2 147 132.943	2 276.217	479 538.210	2 147 141.440	479 538.404	2 147 136.944	479 538.750	2 147 128.952	479 538.945	2 147 124.456	2 275.377
S80	0+ 140.570	17.00	479 539.951	2 147 133.002	2 276.181	479 539.645	2 147 141.497	479 539.807	2 147 137.000	479 540.095	2 147 129.005	479 540.257	2 147 124.508	2 275.341
S81	0+ 139.195	17.00	479 541.325	2 147 133.047	2 276.144	479 541.081	2 147 141.543	479 541.210	2 147 137.045	479 541.440	2 147 129.049	479 541.570	2 147 124.550	2 275.304
S82	0+ 137.820	17.00	479 542.700	2 147 133.081	2 276.108	479 542.517	2 147 141.579	479 542.614	2 147 137.081	479 542.786	2 147 129.082	479 542.883	2 147 124.583	2 275.268
S83 (CENTRO DE CLARO)	0+ 136.320	17.00	479 544.200	2 147 133.108	2 276.068	479 544.084	2 147 141.607	479 544.145	2 147 137.107	479 544.254	2 147 129.108	479 544.315	2 147 124.609	2 275.228
S84	0+ 134.820	17.00	479 545.700	2 147 133.122	2 276.028	479 545.651	2 147 141.622	479 545.677	2 147 137.122	479 545.722	2 147 129.122	479 545.748	2 147 124.622	2 275.188
S85	0+ 133.445	17.00	479 547.075	2 147 133.125	2 275.991	479 547.088	2 147 141.625	479 547.081	2 147 137.122	479 547.068	2 147 129.125	479 547.061	2 147 124.625	2 275.151
S86	0+ 132.070	17.00	479 548.450	2 147 133.118	2 275.954	479 548.524	2 147 141.618	479 548.485	2 147 137.118	479 548.414	2 147 129.118	479 548.375	2 147 124.618	2 275.114
S87	0+ 130.695	17.00	479 549.825	2 147 133.101	2 275.918	479 549.961	2 147 141.600	479 549.885	2 147 136.852	479 549.764	2 147 129.340	479 549.688	2 147 124.602	2 275.078
S88	0+ 129.320	17.00	479 551.199	2 147 133.074	2 275.881	479 551.397	2 147 141.572	479 551.266	2 147 135.958	479 551.131	2 147 130.150	479 551.001	2 147 124.576	2 275.041
S89 (COLUMNA 8)	0+ 127.820	17.00	479 552.699	2 147 133.033	2 275.841	479 552.964	2 147 141.529	-	-	-	-	479 552.434	2 147 124.537	2 275.001
S90	0+ 126.320	11.27	479 554.198	2 147 132.980	2 275.801	479 554.418	2 147 138.600	-	-	-	-	479 553.977	2 147 127.340	2 274.961
S91	0+ 124.945	9.53	479 555.571	2 147 132.917	2 275.765	479 555.792	2 147 137.666	-	-	-	-	479 555.350	2 147 128.148	2 274.925
S92 (CENTRO DE CLARO)	0+ 123.570	9.00	479 556.945	2 147 132.853	2 275.728	479 557.186	2 147 137.346	-	-	-	-	479 556.703	2 147 128.359	2 274.888
S93	0+ 122.195	9.00	479 558.318	2 147 132.774	2 275.691	479 558.591	2 147 137.266	-	-	-	-	479 558.044	2 147 128.283	2 274.851
S94	0+ 120.820	9.00	479 559.690	2 147 132.686	2 275.655	479 559.996	2 147 137.175	-	-	-	-	479 559.384	2 147 128.196	2 274.815
S95 (COLUMNA 9)	0+ 119.320	9.00	479 561.186	2 147 132.578	2 275.615	479 561.527	2 147 137.065	-	-	-	-	479 560.844	2 147 128.091	2 274.775
S96	0+ 117.920	9.00	479 562.581	2 147 132.466	2 275.578	479 563.062	2 147 136.942	-	-	-	-	479 562.307	2 147 127.973	2 274.738
S97	0+ 116.460	9.00	479 564.036	2 147 132.339	2 275.539	479 564.445	2 147 136.820	-	-	-	-	479 563.627	2 147 127.858	2 274.699
S98 (JUNTA)	0+ 115.060	9.00	479 565.430	2 147 132.207	2 275.501	479 565.879	2 147 136.684	-	-	-	-	479 564.980	2 147 127.729	2 274.661
S99 (JUNTA)	0+ 114.460	9.00	479 566.026	2 147 132.147	2 275.485	479 566.476	2 147 136.624	-	-	-	-	479 565.577	2 147 127.669	2 274.645
S100	0+ 113.060	9.00	479 567.419	2 147 132.000	2 275.448	479 567.908	2 147 136.473	-	-	-	-	479 566.929	2 147 127.526	2 274.608
S101	0+ 111.600	9.00	479 568.869	2 147 131.835	2 275.409	479 569.288	2 147 136.317	-	-	-	-	479 568.245	2 147 127.378	2 274.569
S102 (COLUMNA 10)	0+ 110.199	9.00	479 570.260	2 147 131.667	2 275.372	479 570.812	2 147 136.133	-	-	-	-	479 569.708	2 147 127.201	2 274.532
S103	0+ 108.700	9.00	479 571.747	2 147 131.476	2 275.332	479 572.339	2 147 135.936	-	-	-	-	479 571.155	2 147 127.015	2 274.492
S104	0+ 107.325	9.00	479 573.109	2 147 131.290	2 275.295	479 573.734	2 147 135.746	-	-	-	-	479 572.485	2 147 126.833	2 274.455
S105 (CENTRO DE CLARO)	0+ 105.950	9.00	479 574.470	2 147 131.094	2 275.259	479 575.127	2 147 135.546	-	-	-	-	479 573.814	2 147 126.642	2 274.419
S106	0+ 104.575	9.53	479 575.830	2 147 130.888	2 275.222	479 576.557	2 147 135.582	-	-	-	-	479 575.098	2 147 126.166	2 274.382
S107	0+ 103.200	11.27	479 577.188	2 147 130.673	2 275.185	479 578.089	2 147 136.224	-	-	-	-	479 576.283	2 147 125.102	2 274.345
S108 (COLUMNA 11)	0+ 101.700	17.00	479 578.668	2 147 130.427	2 275.146	479 580.096	2 147 136.806	-	-	-	-	479 577.239	2 147 122.048	2 274.306
S109	0+ 100.200	17.00	479 580.145	2 147 130.169	2 275.106	479 581.640	2 147 138.536	479 580.653	2 147 133.009	479 579.631	2 147 127.290	479 578.651	2 147 121.801	2 274.266
S110	0+ 098.825	17.00	479 581.498	2 147 129.922	2 275.069	479 583.053	2 147 138.279	479 582.184	2 147 133.610	479 580.810	2 147 126.224	479 579.943	2 147 121.566	2 274.229
S111	0+ 097.450	17.00	479 582.849	2 147 129.666	2 275.032	479 584.465	2 147 138.011	479 583.609	2 147 133.593	479 582.089	2 147 125.739	479 581.233	2 147 121.321	2 274.192
S112	0+ 096.075	17.00	479 584.197	2 147 129.395	2 274.996	479 585.874	2 147 137.733	479 584.987	2 147 133.321	479 583.409	2 147 125.478	479 582.522	2 147 121.066	2 274.156
S113	0+ 094.700	17.00	479 585.545	2 147 129.123	2 274.959	479 587.281	2 147 137.444	479 586.362	2 147 133.039	479 584.728	2 147 125.208	479 583.808	2 147 120.803	2 274.119
S114 (CENTRO DE CLARO)	0+ 093.200	17.00	479 587.011	2 147 128.805	2 274.919	479 588.814	2 147 137.118	479 587.860	2 147 132.720	479 586.164	2 147 124.902	479 585.210	2 147 120.504	2 274.079
S115	0+ 091.700	17.00	479 588.477	2 147 128.487	2 274.879	479 590.344	2 147 136.780	479 589.356	2 147 132.390	479 587.598	2 147 124.585	479 586.609	2 147 120.195	2 274.039
S116	0+ 090.325	17.00	479 589.816	2 147 128.176	2 274.843	479 591.745	2 147 136.459	479 590.724	2 147 132.076	479 588.910	2 147 124.285	479 587.889	2 147 119.902	2 274.003
S117	0+ 088.950	17.00	479 591.155	2 147 127.864	2 274.806	479 593.143	2 147 136.128	479 592.090	2 147 131.753	479 590.219	2 147 123.975	479 589.167	2 147 119.599	2 273.966
S118	0+ 087.575	17.00	479 592.491	2 147 127.537	2 274.769	479 594.538	2 147 135.787	479 593.394	2 147 131.178	479 591.585	2 147 123.887	479 590.443	2 147 119.288	2 273.929
S119	0+ 086.200	17.00	479 593.824	2 147 127.201	2 274.733	479 595.931	2 147 135.436	479 594.539	2 147 129.996	479 593.099	2 147 124.368	479 591.717	2 147 118.967	2 273.893
S120 (COLUMNA 12)	0+ 084.700	17.00	479 595.276	2 147 126.824	2 274.693	479 597.448	2 147 135.041	-	-	-	-	479 593.103	2 147 118.606	2 273.853
S121	0+ 083.200	11.27	479 596.724	2 147 126.435	2 274.618	479 598.204	2 147 131.860	-	-	-	-	479 595.239	2 147 120.989	2 273.778
S122	0+ 081.825	9.53	479 598.048	2 147 126.063	2 274.549	479 599.333	2 147 130.641	-	-	-	-	479 596.758	2 147 121.466	2 273.709
S123	0+ 080.454	9.00	479 599.368	2 147 125.693	2 274.480	479 600.620	2 147 130.015	-	-	-	-	479 598.125	2 147 121.368	2 273.640
S124	0+ 079.075	9.00	479 600.690	2 147 125.301	2 274.411	479 601.970	2 147 129.620	-	-	-	-	479 599.413	2 147 120.991	2 273.571
S125	0+ 077.700	9.00	479 602.009	2 147 124.910	2 274.343	479 603.318	2 147 129.215	-	-	-	-	479 600.699	2 147 120.605	2 273.503
S126 (CENTRO DE CLARO)	0+ 076.200	9.00	479 603.442	2 147 124.468	2 274.268	479 604.786	2 147 128.763	-	-	-	-	479 602.098	2 147 120.173	2 273.428
S127	0+ 074.700	9.00	479 604.872	2 147 124.014	2 274.193	479 606.249	2 147 128.298	-	-	-	-	479 603.494	2 147 119.730	2 273.353
S128	0+ 073.325	9.00	479 606.178	2 147 123.584	2 274.124	479 607.588	2 147 127.863	-	-	-	-	479 604.770	2 147 119.315	2 273.284
S129	0+ 071.950	9.00	479 607.483	2 147 123.154	2 274.055	479 608.923	2 147 127.417	-	-	-	-	479 606.044	2 147 118.890	2 273.215
S130	0+ 070.575	9.53	479 608.785	2 147 122.709	2 273.987	479 610.337	2 147 127.198	-	-	-	-	479 607.223	2 147 118.192	2 273.147
S131	0+ 069.200	11.27	479 610.082	2 147 122.255	2 273.918	479 611.959	2 147 127.557	-	-	-	-	479 608.199	2 147 116.934	2 273.078
S132 (COLUMNA 13)	0+ 067.700	17.00	479 611.495	2 147 121.749	2 273.843	479 614.393	2 147 129.739	-	-	-	-	479 608.596	2 147 113.759	2 273.003
S133	0+ 066.275	17.00	479 612.903	2 147 121.232	2 273.768	479 615.864	2 147 129.199	479 613.811	2 147 123.893	479 611.839	2 147 118.583	479 609.941	2 147 113.265	2 272.928
S134	0+ 064.900	17.00	479 614.190	2 147 120.748	2 273.699	479 617.209	2 147 128.693	479 615.441	2 147 124.255	479 612.795	2 147 117.284	479 611.170	2 147 112.802	2 272.859
S135	0+ 063.525	17.00	479 615.473	2 147 120.255	2 273.631	479 618.550	2 147 128.178	479 616.850	2 147 124.011	479 614.025	2 147 116.526	479 612.396	2 147 112.331	2 272.791
S136	0+ 062.150	17.00	479 616.753	2 147 119.752	2 273.562	479 619.888	2 147 127.653	479 618.157	2 147 123.499	479 615.210	2 147 116.061	479 613.619	2 147 111.852	2 272.722
S137	0+ 060.775	17.00	479 618.029	2 147 119.241	2 273.493	479 621.221	2 147 127.119	479 619.460	2 147 122.977	479 616.459	2 147 115.561	479 614.838	2 147 111.363	2 272.653
S138 (CENTRO DE CLARO)	0+ 059.350	17.00	479 619.279	2 147 118.729	2 273.426	479 622.526	2 147 126.585	479 620.807	2 147 122.426	479 617.750	2 147 115.033	479 616.031	2 147 110.874	2 272.586
S139	0+ 057.925	17.00	479 620.524	2 147 118.209	2 273.358	479 623.828	2 147 126.041	479 622.150	2 147 121.865	479 619.038	2 147 114.495	479 617.221	2 147 110.377	2 272.518
S140	0+ 056.550	17.00	479 621.789	2 147 117.670	2 273.290	479 625.149	2 147 125.478	479 623.441	2 147 121.314	479 620.276	2 147 113.967	479 618.429	2 147 109.863	2 272.450
S141	0+ 055.175	17.00	479 623.050	2 147 117.122	2 273.221	479 626.467	2 147 124.905	479 624.728	2 147 120.753	479 621.510	2 147 113.431	479 619.634	2 147 109.339	2 272.381
S142	0+ 053.800	17.00	479 624.307	2 147 116.565	2 273.152	479 627.780	2 147 124.323	479 625.898	2 147 119.931	479 622.849	2 147 113.127	479 620.835	2 147 108.807	2 272.312
S143	0+ 052.425	17.00	479 625.560	2 147 115.999	2 273.084	479 629.089	2 147 123.731	479 626.797	2 147 118.524	479 624.443	2 147 113.372	479 622.031	2 147 108.266	2 272.244
S144 (COLUMNA 14)	0+ 051.000	17.00	479 626.923	2 147 115.370	2 273.009	479 630.513	2 147 123.075	-	-	-	-	479 623.333	2 147 107.666	2 272.169

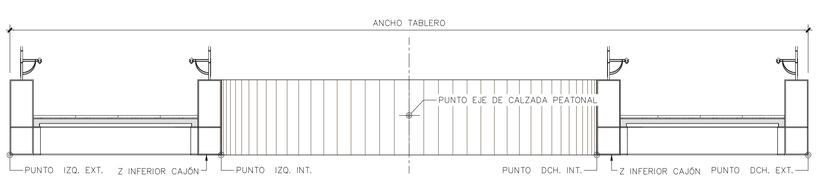
TABLA DE REPLANTEO
SIN ESCALA



SECCIÓN CORRESPONDIENTE A CLARO TIPO
ESCALA 1:60



SECCIÓN CORRESPONDIENTE A ZONA DE TRANSICIÓN
ESCALA 1:60



SECCIÓN CORRESPONDIENTE A TABLERO EN ÓCULO
ESCALA 1:60

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FIDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FIDEL INGENIERÍA Y ARQUITECTURA S.A. DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1450

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0985

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO
GEOMETRÍA Y REPLANTEO (III)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No:
DGOT-20-EST-III-0074-00275-P-00

ESCALA GRÁFICA: 0 5 10 15 20

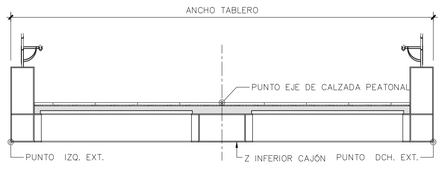
CONTROL	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:60
FECHA: JULIO 2021
ESC:
ACOT: METROS

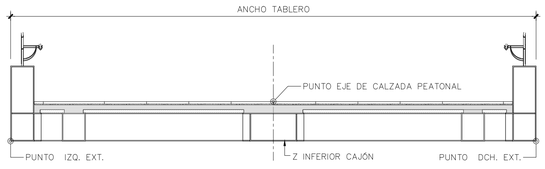
DGOT-20-EST-III-0074-00275-P-00

SECCIÓN	P.K	ANCHO TABLERO	PUNTOS DE REPLANTEO											Z INF. CAJÓN
			EJE DE TABLERO			IZQ. EXT		IZQ. INT		DCH. INT.		DCH. EXT		
			X	Y	Z	X	Y	X	Y	X	Y	X	Y	
S144 (COLUMNA 14)	0+ 051.000	17.00	479 626.923	2 147 115.370	2 273.009	479 630.513	2 147 123.075	-	-	-	-	479 623.333	2 147 107.666	2 272.169
S145	0+ 049.500	11.27	479 628.280	2 147 114.732	2 272.934	479 630.695	2 147 119.810	-	-	-	-	479 625.855	2 147 109.634	2 272.094
S146	0+ 048.125	9.53	479 629.519	2 147 114.136	2 272.865	479 631.590	2 147 118.411	-	-	-	-	479 627.435	2 147 109.836	2 272.025
S147	0+ 046.750	9.00	479 630.755	2 147 113.532	2 272.796	479 632.746	2 147 117.568	-	-	-	-	479 628.763	2 147 109.497	2 271.956
S148	0+ 045.375	9.00	479 631.985	2 147 112.920	2 272.728	479 634.006	2 147 116.940	-	-	-	-	479 629.965	2 147 108.899	2 271.888
S149	0+ 044.000	9.00	479 633.212	2 147 112.298	2 272.659	479 635.261	2 147 116.304	-	-	-	-	479 631.162	2 147 108.292	2 271.819
S150 (CENTRO DE CLARO)	0+ 042.501	9.00	479 634.544	2 147 111.609	2 272.584	479 636.625	2 147 115.599	-	-	-	-	479 632.462	2 147 107.620	2 271.744
S151	0+ 041.000	9.00	479 635.871	2 147 110.910	2 272.509	479 637.984	2 147 114.883	-	-	-	-	479 633.759	2 147 106.937	2 271.669
S152	0+ 039.625	9.00	479 637.081	2 147 110.256	2 272.440	479 639.225	2 147 114.218	-	-	-	-	479 634.942	2 147 106.302	2 271.600
S153	0+ 038.251	9.00	479 638.290	2 147 109.602	2 272.372	479 640.460	2 147 113.544	-	-	-	-	479 636.120	2 147 105.659	2 271.532
S154	0+ 036.875	9.00	479 639.492	2 147 108.934	2 272.303	479 641.691	2 147 112.860	-	-	-	-	479 637.294	2 147 105.008	2 271.463
S155	0+ 035.500	9.00	479 640.692	2 147 108.263	2 272.234	479 642.916	2 147 112.168	-	-	-	-	479 638.462	2 147 104.348	2 271.394
S156 (COLUMNA 15)	0+ 034.000	9.00	479 641.990	2 147 107.510	2 272.159	479 644.248	2 147 111.403	-	-	-	-	479 639.732	2 147 103.618	2 271.319
S157	0+ 032.500	9.00	479 643.287	2 147 106.758	2 272.084	479 645.573	2 147 110.627	-	-	-	-	479 640.996	2 147 102.878	2 271.244
S158	0+ 031.125	9.00	479 644.466	2 147 106.049	2 272.016	479 646.782	2 147 109.907	-	-	-	-	479 642.149	2 147 102.191	2 271.176
S159	0+ 029.750	9.00	479 645.642	2 147 105.337	2 271.947	479 647.987	2 147 109.178	-	-	-	-	479 643.297	2 147 101.496	2 271.107
S160	0+ 028.375	9.00	479 646.813	2 147 104.616	2 271.878	479 649.185	2 147 108.440	-	-	-	-	479 644.441	2 147 100.792	2 271.038
S161	0+ 027.000	9.00	479 647.979	2 147 103.887	2 271.809	479 650.379	2 147 107.694	-	-	-	-	479 645.579	2 147 100.080	2 270.969
S162 (CENTRO DE CLARO)	0+ 025.501	9.00	479 649.244	2 147 103.083	2 271.735	479 651.674	2 147 106.870	-	-	-	-	479 646.815	2 147 099.295	2 270.895
S163	0+ 024.000	9.00	479 650.501	2 147 102.262	2 271.660	479 652.964	2 147 106.035	-	-	-	-	479 648.044	2 147 098.499	2 270.820
S164	0+ 022.625	9.00	479 651.652	2 147 101.511	2 271.591	479 654.140	2 147 105.262	-	-	-	-	479 649.165	2 147 097.761	2 270.751
S165	0+ 021.250	9.00	479 652.796	2 147 100.747	2 271.522	479 655.310	2 147 104.479	-	-	-	-	479 650.281	2 147 097.015	2 270.682
S166	0+ 019.875	9.53	479 653.933	2 147 099.975	2 271.453	479 656.615	2 147 103.895	-	-	-	-	479 651.234	2 147 096.031	2 270.613
S167	0+ 018.500	11.27	479 655.065	2 147 099.194	2 271.385	479 658.274	2 147 103.813	-	-	-	-	479 651.844	2 147 094.559	2 270.545
S168 (COLUMNA 16)	0+ 017.000	17.00	479 656.294	2 147 098.333	2 271.310	479 661.199	2 147 105.275	-	-	-	-	479 651.388	2 147 091.392	2 270.470
S169	0+ 015.500	17.00	479 657.515	2 147 097.463	2 271.235	479 662.475	2 147 104.365	479 659.199	2 147 099.806	479 655.808	2 147 095.088	479 652.555	2 147 090.560	2 270.395
S170	0+ 014.125	17.00	479 658.629	2 147 096.657	2 271.166	479 663.639	2 147 103.523	479 660.840	2 147 099.687	479 656.412	2 147 093.618	479 653.618	2 147 089.790	2 270.326
S171	0+ 012.750	17.00	479 659.737	2 147 095.842	2 271.097	479 664.796	2 147 102.672	479 662.118	2 147 099.056	479 657.363	2 147 092.623	479 654.677	2 147 089.012	2 270.257
S172	0+ 011.375	17.00	479 660.838	2 147 095.020	2 271.029	479 665.948	2 147 101.813	479 663.243	2 147 098.216	479 658.419	2 147 091.803	479 655.729	2 147 088.226	2 270.189
S173	0+ 010.000	17.00	479 661.934	2 147 094.189	2 270.960	479 667.093	2 147 100.945	479 664.362	2 147 097.368	479 659.482	2 147 090.978	479 656.776	2 147 087.433	2 270.120
S174	0+ 008.500	17.00	479 663.123	2 147 093.274	2 270.885	479 668.334	2 147 099.989	479 665.575	2 147 096.434	479 660.642	2 147 090.077	479 657.911	2 147 086.559	2 270.045
S175	0+ 007.000	17.00	479 664.304	2 147 092.350	2 270.810	479 669.569	2 147 099.023	479 666.782	2 147 095.490	479 661.802	2 147 089.177	479 659.040	2 147 085.676	2 269.970
S176	0+ 005.625	17.00	479 665.381	2 147 091.494	2 270.741	479 670.693	2 147 098.129	479 667.881	2 147 094.617	479 662.865	2 147 088.352	479 660.068	2 147 084.859	2 269.901
S177 (CENTRO DE CLARO)	0+ 004.250	17.00	479 666.451	2 147 090.631	2 270.673	479 671.812	2 147 097.227	479 668.974	2 147 093.735	479 663.928	2 147 087.527	479 661.090	2 147 084.034	2 269.833
S178	0+ 002.875	17.00	479 667.515	2 147 089.760	2 270.604	479 672.923	2 147 096.317	479 669.902	2 147 092.654	479 665.122	2 147 086.858	479 662.106	2 147 083.202	2 269.764
S179	0+ 001.500	17.00	479 668.572	2 147 088.881	2 270.535	479 674.028	2 147 095.399	479 670.424	2 147 091.093	479 666.695	2 147 086.638	479 663.117	2 147 082.363	2 269.695
S180 (CABALLETE 2)	0+ 000.001	17.00	479 669.719	2 147 087.914	2 270.460	479 675.226	2 147 094.389	-	-	-	-	479 664.212	2 147 081.439	2 269.620

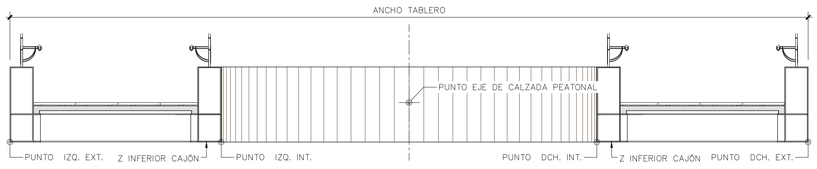
TABLA DE REPLANTEO
SIN ESCALA



SECCIÓN CORRESPONDIENTE A CLARO TIPO
ESCALA 1:60



SECCIÓN CORRESPONDIENTE A ZONA DE TRANSICIÓN
ESCALA 1:60



SECCIÓN CORRESPONDIENTE A TABLERO EN ÓCULO
ESCALA 1:60

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1488

CORresponsal ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE 5466

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO
GEOMETRÍA Y REPLANTEO (IV)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0075-00276-P-00

ESCALA GRÁFICA: 0.0 1.0 3

SECTOR	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:60
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC:
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ACOT. METROS

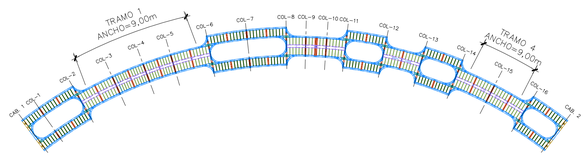
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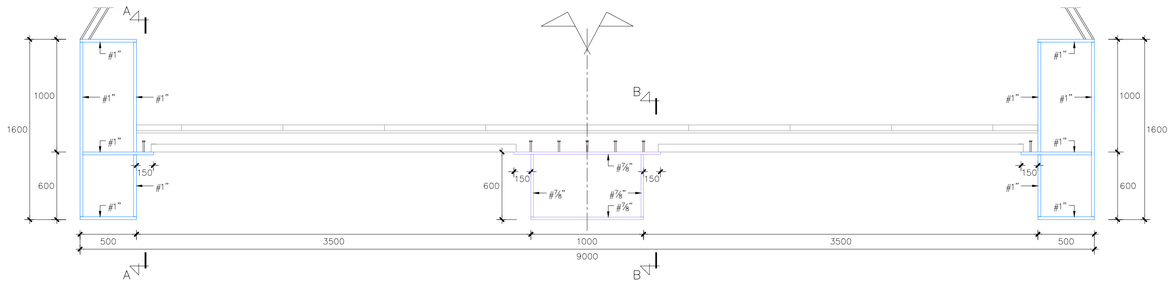
SIMBOLOGÍA (TABLERO = 9,00m)

- CAJÓN METÁLICO LATERAL
- CAJÓN METÁLICO CENTRAL
- TRAVESA PRINCIPAL SOBRE COLUMNA
- TRAVESA PRINCIPAL EN CENTRO DE CLARO
- TRAVESA SECUNDARIA (W14x53)
- PERNOS NELSON

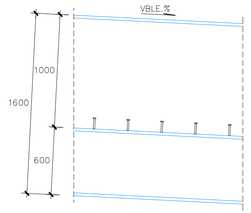
ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

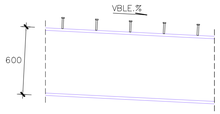




SECCIÓN TIPO

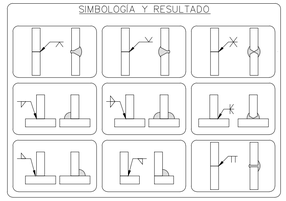


SECCIÓN A–A

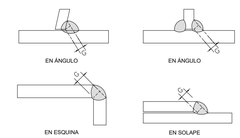


SECCIÓN B–B

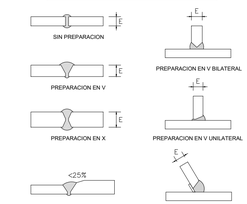
SIMBOLOGÍA Y RESULTADO

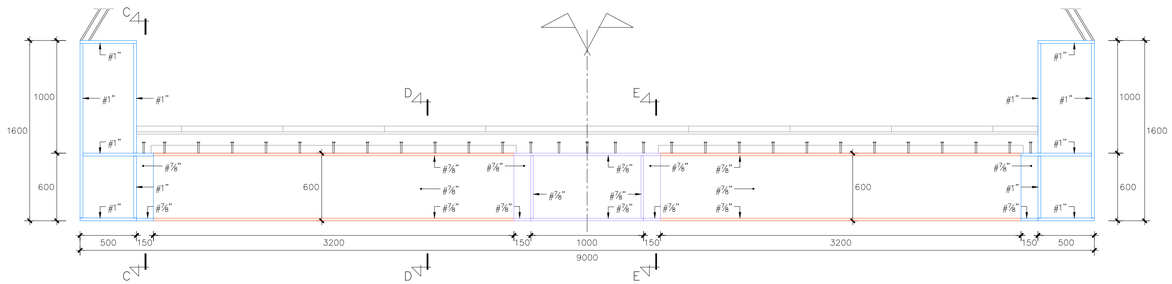


CORDÓN DE SOLDADURA EN ÁNGULO

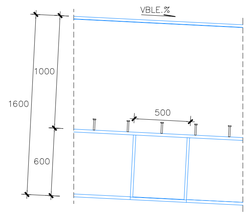


CORDÓN DE SOLDADURA A TOPE

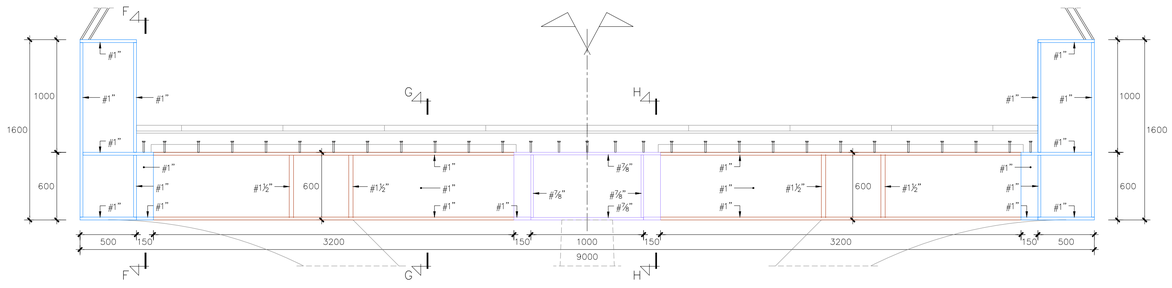




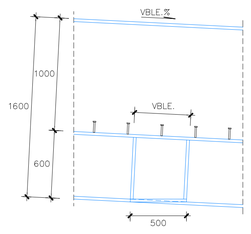
SECCIÓN TIPO EN CENTRO DE CLARO



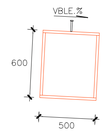
SECCIÓN C–C



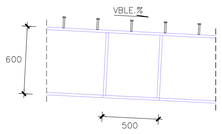
SECCIÓN TIPO SOBRE COLUMNA



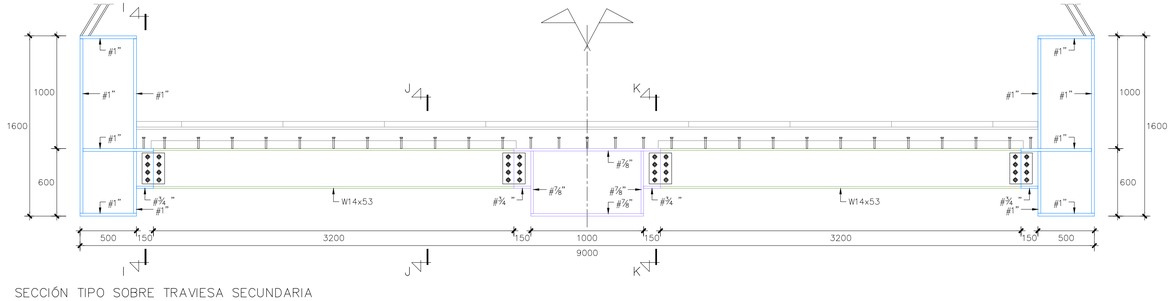
SECCIÓN F–F



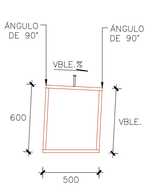
SECCIÓN D–D



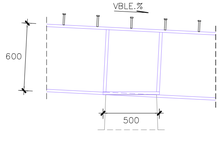
SECCIÓN E–E



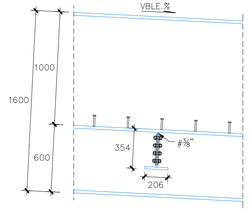
SECCIÓN TIPO SOBRE TRAVIESA SECUNDARIA



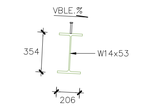
SECCIÓN G–G



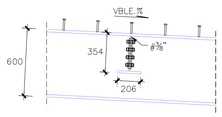
SECCIÓN H–H



SECCIÓN I–I



SECCIÓN J–J



SECCIÓN K–K

SECCIONES ANCHO TABLERO= 9,00m . TRAMO 1 Y 4

ESCALA 1:25

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0495

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN- AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA SECCIONES TIPO (I)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.
DGOT-20-EST-III-0076-00277-P-00

ESCALA GRÁFICA: 0 0.25 0.75 1.25 2.5

DETALLE	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ	

MOD: 1:25
FECHA: JULIO 2021
ESC:
ACOT: METROS

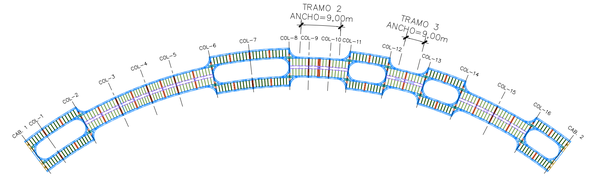
DGOT-20-EST-III-0076-00277-P-00

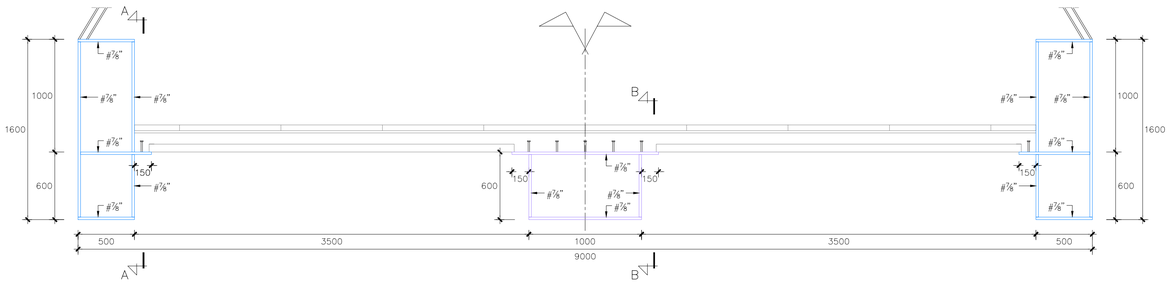
SIMBOLOGÍA (TABLERO = 9,00m)

- CAJÓN METÁLICO LATERAL
- CAJÓN METÁLICO CENTRAL
- TRAVESA PRINCIPAL SOBRE COLUMNA
- TRAVESA PRINCIPAL EN CENTRO DE CLARO
- TRAVESA SECUNDARIA (W14x53)
- PERNOS NELSON

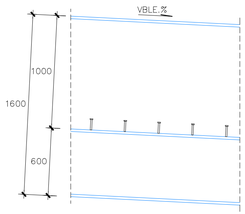
ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

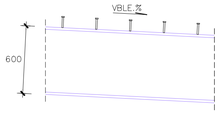




SECCIÓN TIPO

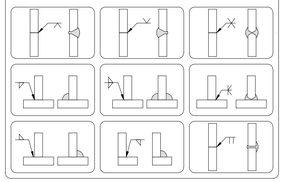


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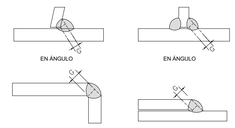


SECCIÓN B–B

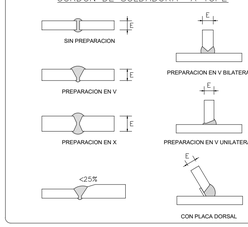
SIMBOLOGÍA Y RESULTADO

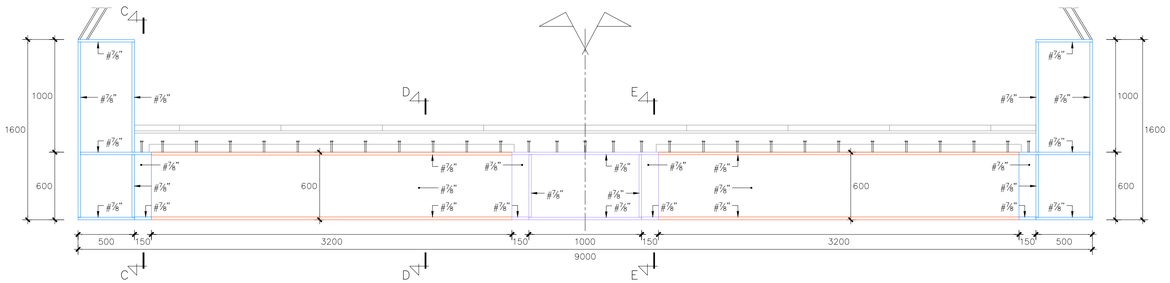


CORDÓN DE SOLDADURA EN ÁNGULO

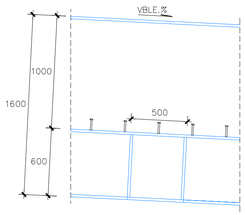


CORDÓN DE SOLDADURA A TOPE

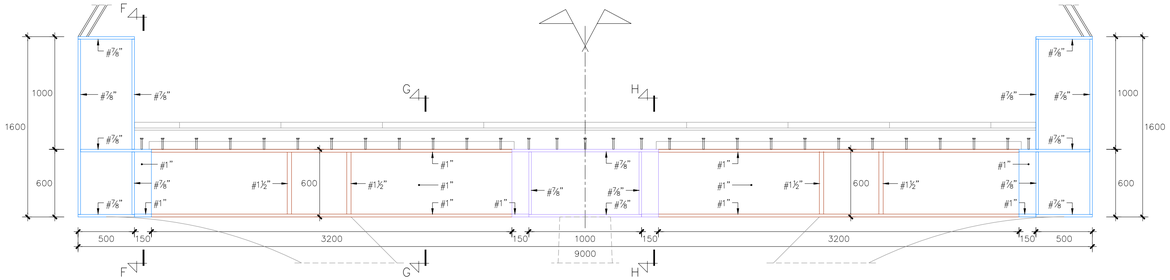




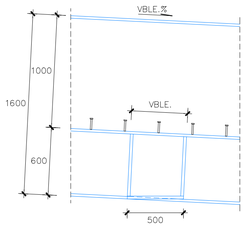
SECCIÓN TIPO EN CENTRO DE CLARO



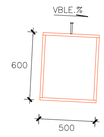
SECCIÓN C–C



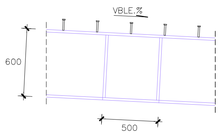
SECCIÓN TIPO SOBRE COLUMNA



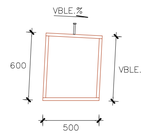
SECCIÓN F–F



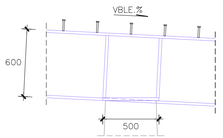
SECCIÓN D–D



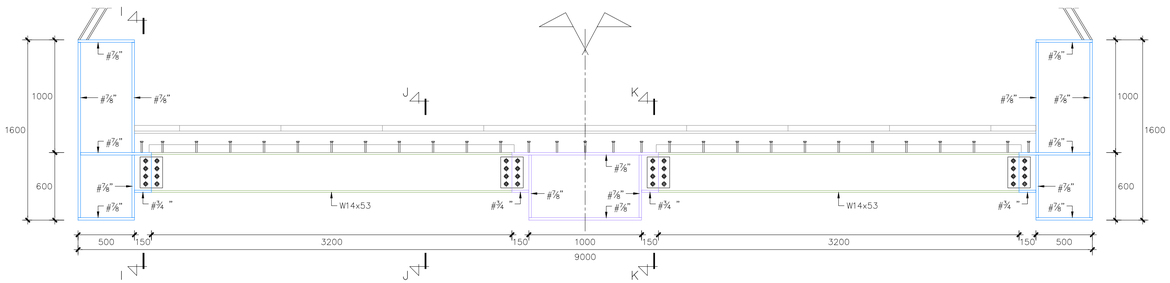
SECCIÓN E–E



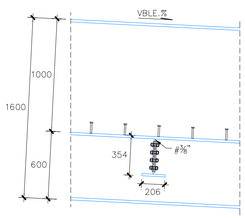
SECCIÓN G–G



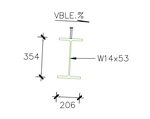
SECCIÓN H–H



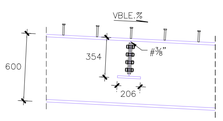
SECCIÓN TIPO SOBRE TRAVIESA SECUNDARIA



SECCIÓN I–I



SECCIÓN J–J



SECCIÓN K–K

SECCIONES ANCHO TABLERO= 9,00m . TRAMO 2 Y 3

ESCALA 1:25

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRIDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1466

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDE 5466

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA SECCIONES TIPO (II)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0077-00278-P-00**

ESCALA GRÁFICA: 0.25 0.75 1.25 2.5

ESCALA	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:25
		PROYECTO	M.I. INCOENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC:
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ACOT. METROS

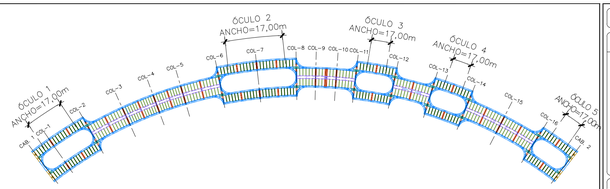
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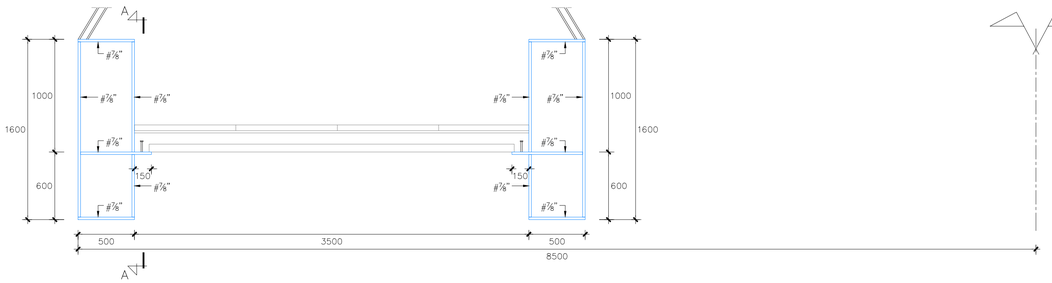
SIMBOLOGÍA (TABLERO = 17.00m)

- CAJÓN METÁLICO LATERAL
- CAJÓN METÁLICO CENTRAL
- TRAVESA PRINCIPAL SOBRE COLUMNA
- TRAVESA PRINCIPAL EN CENTRO DE CLARO
- TRAVESA SECUNDARIA (W14x53)
- PERNOS NELSON

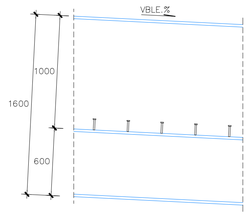
ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

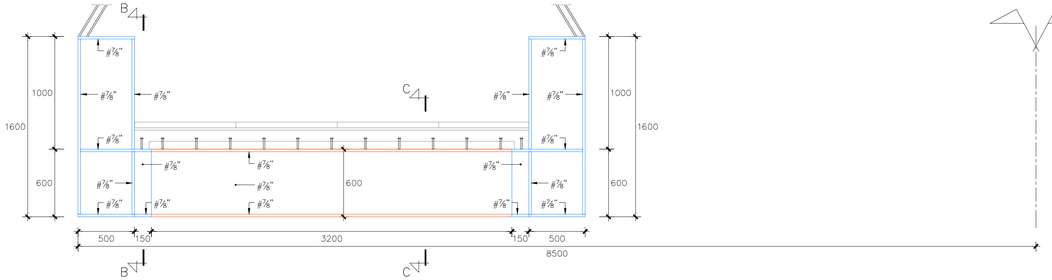




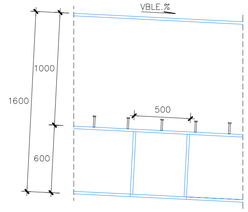
SEMI–SECCIÓN TIPO



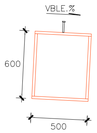
SECCIÓN A–A



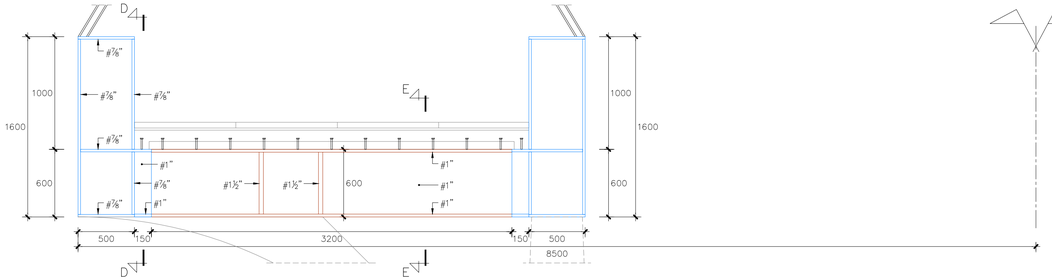
SEMI–SECCIÓN TIPO EN CENTRO DE CLARO



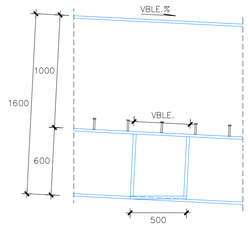
SECCIÓN B–B



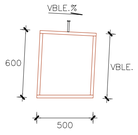
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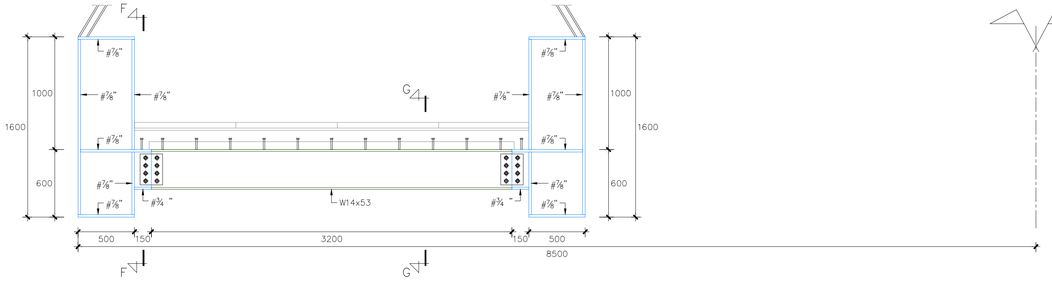
SEMI–SECCIÓN TIPO SOBRE COLUMNA



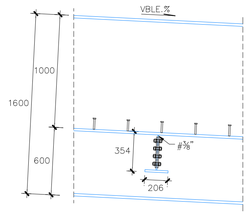
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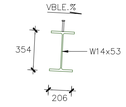
SECCIÓN E–E



SEMI–SECCIÓN TIPO SOBRE TRAVIESA SECUNDARIA



SECCIÓN F–F

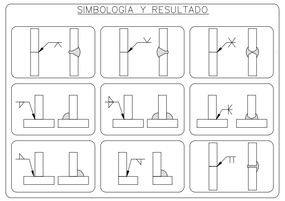


SECCIÓN G–G

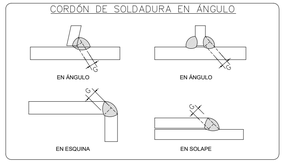
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ESCALA 1:25

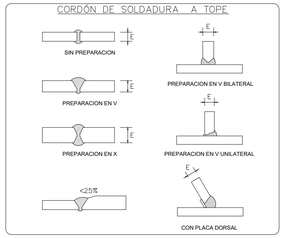
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

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ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA SECCIONES TIPO (III)

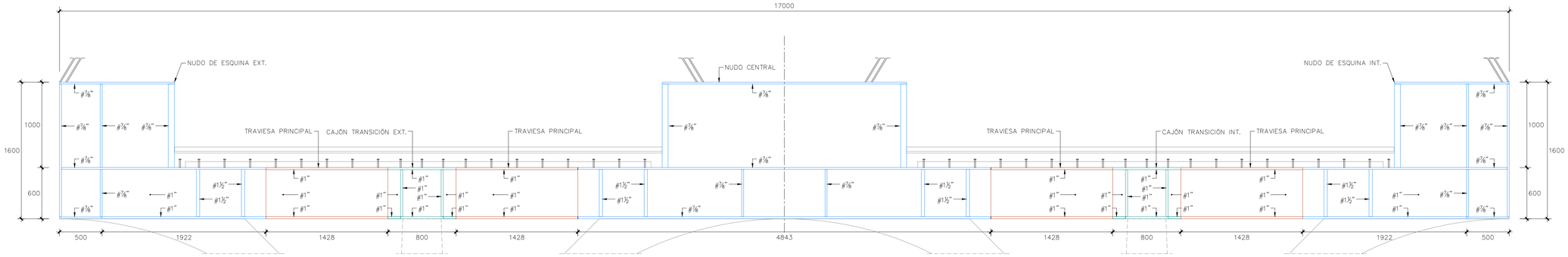
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0078-00279-P-00**

ESCALA GRÁFICA: 0.25 0.75 1.25 2.5

FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:25
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC:
	ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ACOT. METROS

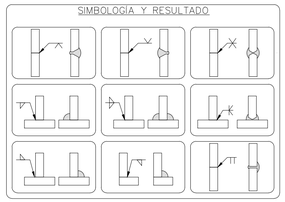
DGOT-20-EST-III-0078-00279-P-00



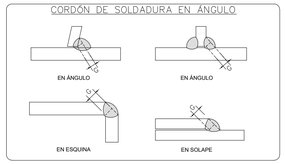
SECCIÓN POR EJE DE COLUMNA EN ZONA DE TRANSICIÓN

ESCALA 1:25

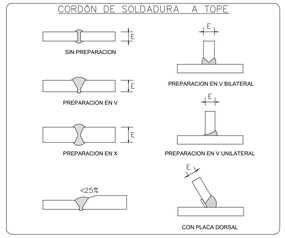
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR UNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CMO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CDMX-3650

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA SECCIONES TIPO (IV)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

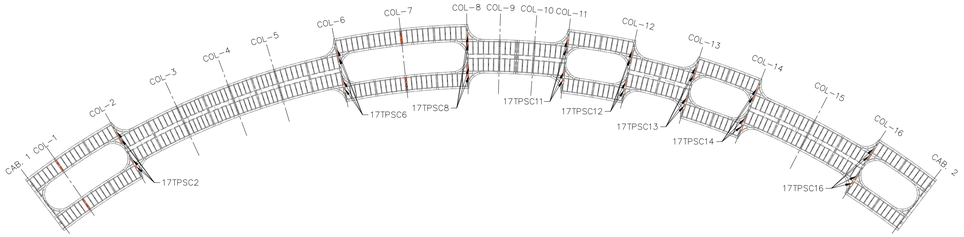
PLANO No.: **DGOT-20-EST-III-0079-00280-P-00**

ESCALA GRÁFICA: 0.25 0.75 1.25 2.5

ESCALA	FECHA	DISEÑO	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ	

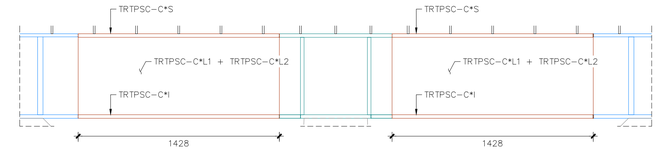
MOD. 1:25
FECHA: JULIO 2021
DIBUJ.
ACOT. METROS

DGOT-20-EST-III-0079-00280-P-00



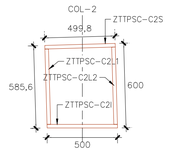
TRAVIESAS PRINCIPALES SOBRE COLUMNA. PLANTA GENERAL

ESCALA 1:500



SECCIÓN TRANSVERSAL

TRAVIESA ZTTPSC-C2



SECCIÓN LONGITUDINAL



PLACA ZTTPSC-C2I
UDS.= 4
ESPESOR= 1"



PLACA ZTTPSC-C2S
UDS.= 4
ESPESOR= 1"



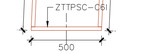
PLACA ZTTPSC-C2L1
UDS.= 4
ESPESOR= 1"



PLACA ZTTPSC-C2L2
UDS.= 4
ESPESOR= 1"



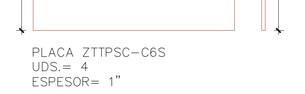
TRAVIESA ZTTPSC-C6



SECCIÓN LONGITUDINAL



PLACA ZTTPSC-C6I
UDS.= 4
ESPESOR= 1"



PLACA ZTTPSC-C6S
UDS.= 4
ESPESOR= 1"



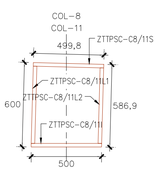
PLACA ZTTPSC-C6L1
UDS.= 4
ESPESOR= 1"



PLACA ZTTPSC-C6L2
UDS.= 4
ESPESOR= 1"



TRAVIESA ZTTPSC-C8/11



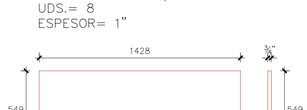
SECCIÓN LONGITUDINAL



PLACA ZTTPSC-C8/11I
UDS.= 8
ESPESOR= 1"



PLACA ZTTPSC-C8/11S
UDS.= 8
ESPESOR= 1"



PLACA ZTTPSC-C8/11L1
UDS.= 8
ESPESOR= 1"



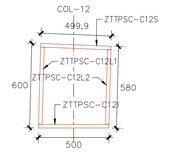
PLACA ZTTPSC-C8/11L2
UDS.= 8
ESPESOR= 1"



ZONA DE TRANSICIÓN. TRAVIESA PRINCIPAL SOBRE COLUMNA

ESCALA 1:20

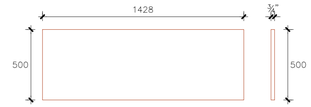
TRAVIESA ZTTPSC-C12



SECCIÓN LONGITUDINAL



PLACA ZTTPSC-C12I
UDS.= 4
ESPESOR= 1"



PLACA ZTTPSC-C12S
UDS.= 4
ESPESOR= 1"



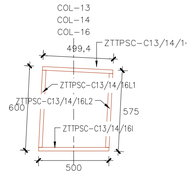
PLACA ZTTPSC-C12L1
UDS.= 4
ESPESOR= 1"



PLACA ZTTPSC-C12L2
UDS.= 4
ESPESOR= 1"



TRAVIESA ZTTPSC-C13/14/16



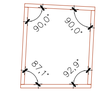
SECCIÓN LONGITUDINAL



PLACA ZTTPSC-C13/14/16I
UDS.= 12
ESPESOR= 1"



PLACA ZTTPSC-C13/14/16S
UDS.= 12
ESPESOR= 1"



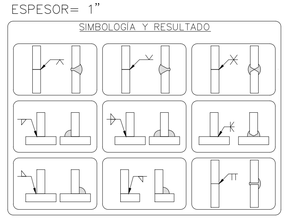


PLACA ZTTPSC-C13/14/16L1
UDS.= 12
ESPESOR= 1"

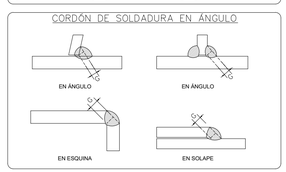


PLACA ZTTPSC-C13/14/16L2
UDS.= 12
ESPESOR= 1"

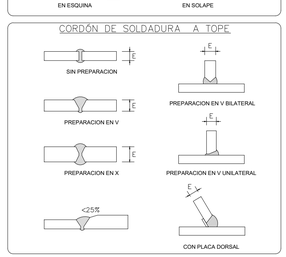
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO. LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MACRO
DRO-1495

CORresponsal ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0295

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN- AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
TRAVIESAS PRINCIPALES (III)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

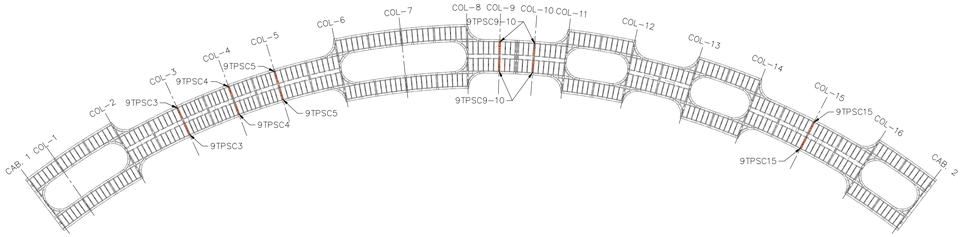
PLANO No.
DGOT-20-EST-III-0083-00284-P-00

ESCALA GRÁFICA: 0 0.5 0.6 1 2

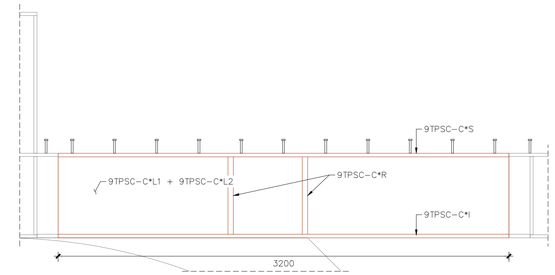
DISEÑÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO ESTRUCTURA	M.I. INOCENCIO MALDONADO TORRES	
			M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA/VB: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0083-00284-P-00

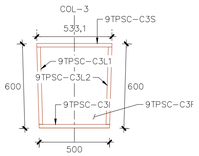


TRAVIESAS PRINCIPALES SOBRE COLUMNA. PLANTA GENERAL
ESCALA 1:500

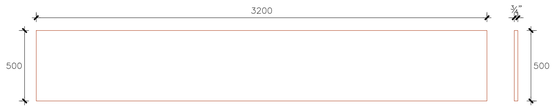


SECCIÓN TRANSVERSAL

TRAVIESA 9TPSC-C3



SECCIÓN LONGITUDINAL



PLACA 9TPSC-C3I
UDS.= 2
ESPESOR= 1"



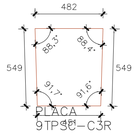
PLACA 9TPSC-C3S
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C3L1
UDS.= 2
ESPESOR= 1"

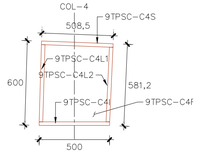


PLACA 9TPSC-C3L2
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C3R
UDS.= 4
ESPESOR= 1½"

TRAVIESA 9TPSC-C4



SECCIÓN LONGITUDINAL



PLACA 9TPSC-C4I
UDS.= 2
ESPESOR= 1"



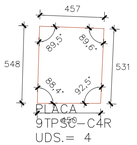
PLACA 9TPSC-C4S
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C4L1
UDS.= 2
ESPESOR= 1"

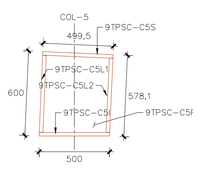


PLACA 9TPSC-C4L2
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C4R
UDS.= 4
ESPESOR= 1½"

TRAVIESA 9TPSC-C5



SECCIÓN LONGITUDINAL



PLACA 9TPSC-C5I
UDS.= 2
ESPESOR= 1"



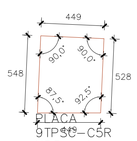
PLACA 9TPSC-C5S
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C5L1
UDS.= 2
ESPESOR= 1"

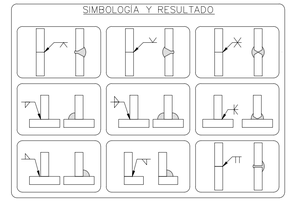


PLACA 9TPSC-C5L2
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C5R
UDS.= 4
ESPESOR= 1½"

ANCHO TABLERO= 9,00m. TRAVIESA PRINCIPAL SOBRE COLUMNA
ESCALA 1:20



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR UNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0065

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
TRAVIESAS PRINCIPALES (IV)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0084-00285-P-00**

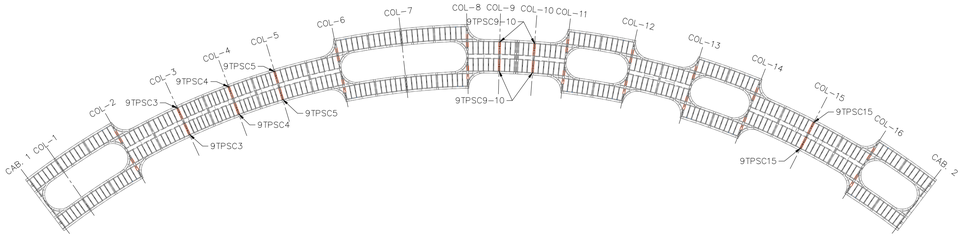
ESCALA GRÁFICA: 0 2.5 5 7.5 10

FECHA	DEPTO	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

DISEÑO

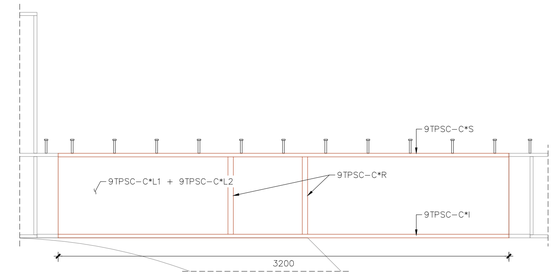
MOD.: 1:20
FECHA: JULIO 2021
ESC.:
ACOT.: METROS

DGOT-20-EST-III-0084-00285-P-00



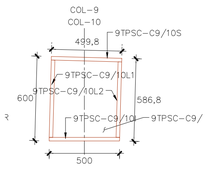
TRAVIESAS PRINCIPALES SOBRE COLUMNA. PLANTA GENERAL

ESCALA 1:500



SECCIÓN TRANSVERSAL

TRAVIESA 9TPSC-C9/10



SECCIÓN LONGITUDIAL



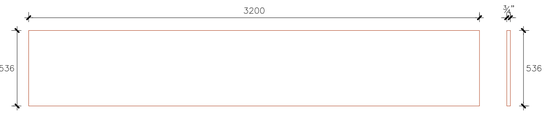
PLACA 9TPSC-C9/10I
UDS.= 4
ESPESOR= 1"



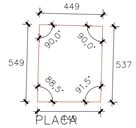
PLACA 9TPSC-C9/10S
UDS.= 4
ESPESOR= 1"



PLACA 9TPSC-C9/10L1
UDS.= 4
ESPESOR= 1"

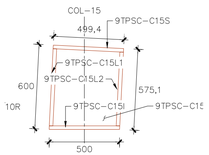


PLACA 9TPSC-C9/10L2
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ESPESOR= 1"

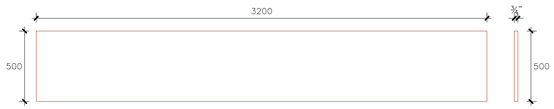


PLACA 9TPSC-C9/10R
UDS.= 8
ESPESOR= 1½"

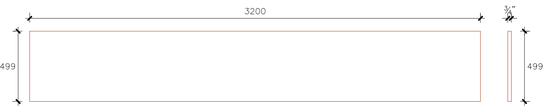
TRAVIESA 9TPSC-C15



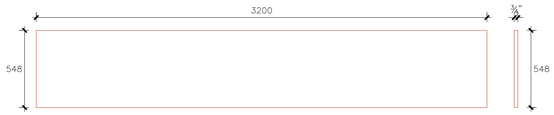
SECCIÓN LONGITUDIAL



PLACA 9TPSC-C15I
UDS.= 2
ESPESOR= 1"



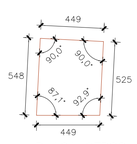
PLACA 9TPSC-C15S
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C15L1
UDS.= 2
ESPESOR= 1"



PLACA 9TPSC-C15L2
UDS.= 2
ESPESOR= 1"

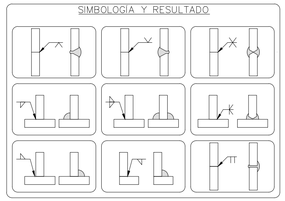


PLACA 9TPSC-C15R
UDS.= 4
ESPESOR= 1½"

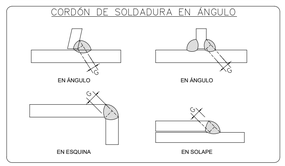
ANCHO TABLERO= 9,00m. TRAVIESA PRINCIPAL SOBRE COLUMNA

ESCALA 1:20

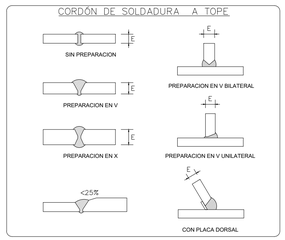
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

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	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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FIEDEL ING. Y ARQ. S.A DE C.V.

ADMINISTRADOR UNICO
FIEDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1450

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COR-0660

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA
TRAVIESAS PRINCIPALES (V)

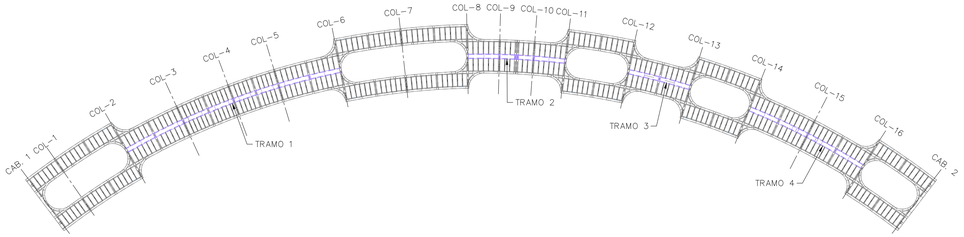
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0085-00286-P-00**

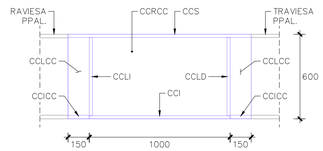
ESCALA GRÁFICA: 0 2 4 6 8 10

ESCALA	FECHA	DISEÑO	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN		
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		CAD.
					ACOT. METROS

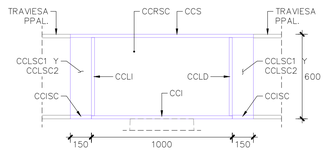
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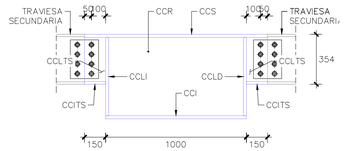
CAJON CENTRAL. PLANTA GENERAL
ESCALA 1:500



ENCUENTRO TIPO 1
ENCUENTRO CON TRAVIESA PPAL.
CENTRO DE CLARO

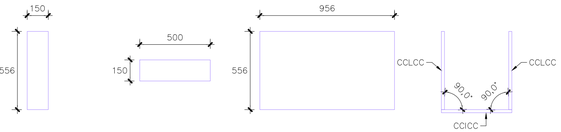


ENCUENTRO TIPO 2
ENCUENTRO CON TRAVIESA PPAL.
SOBRE COLUMNA



ENCUENTRO TIPO 3
ENCUENTRO CON TRAVIESA
SECUNDARIA

CAJÓN CENTRAL. SECCIONES TRANSVERSALES
ESCALA 1:20



PLACA CCLCC
UDS.= 36
ESPESOR= 7/8"

PLACA CCICC
UDS.= 18
ESPESOR= 7/8"

PLACA CCRCC
UDS.= 18
ESPESOR= 7/8"

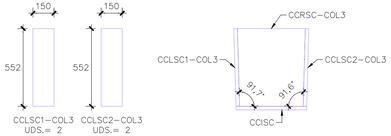
DESPIECE PLACAS ENCUENTRO TIPO 1
ESCALA 1:20



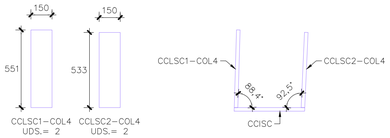
PLACA CCLTS
UDS.= 164
ESPESOR= 3/8"

PLACA CCITS
UDS.= 164
ESPESOR= 3/4"

DESPIECE PLACAS ENCUENTRO TIPO 3
ESCALA 1:20

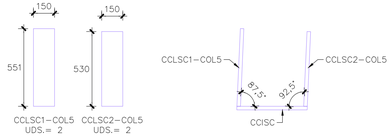


PLACA CCLSC-C3
ESPESOR= 1"

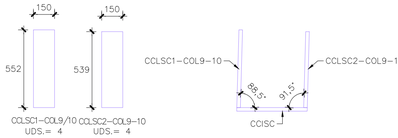


PLACA CCLSC-C4
ESPESOR=1"

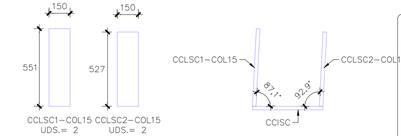
DESPIECE PLACAS ENCUENTRO TIPO 2
ESCALA 1:20



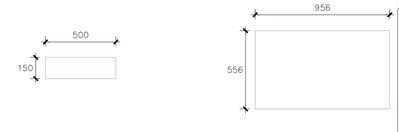
PLACA CCLSC-C5
ESPESOR= 1"



PLACA CCLSC-C9/10
ESPESOR= 1"

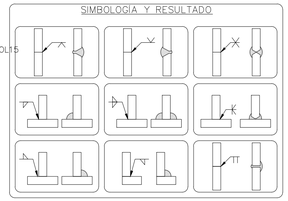


PLACA CCLSC-C15
ESPESOR= 1"

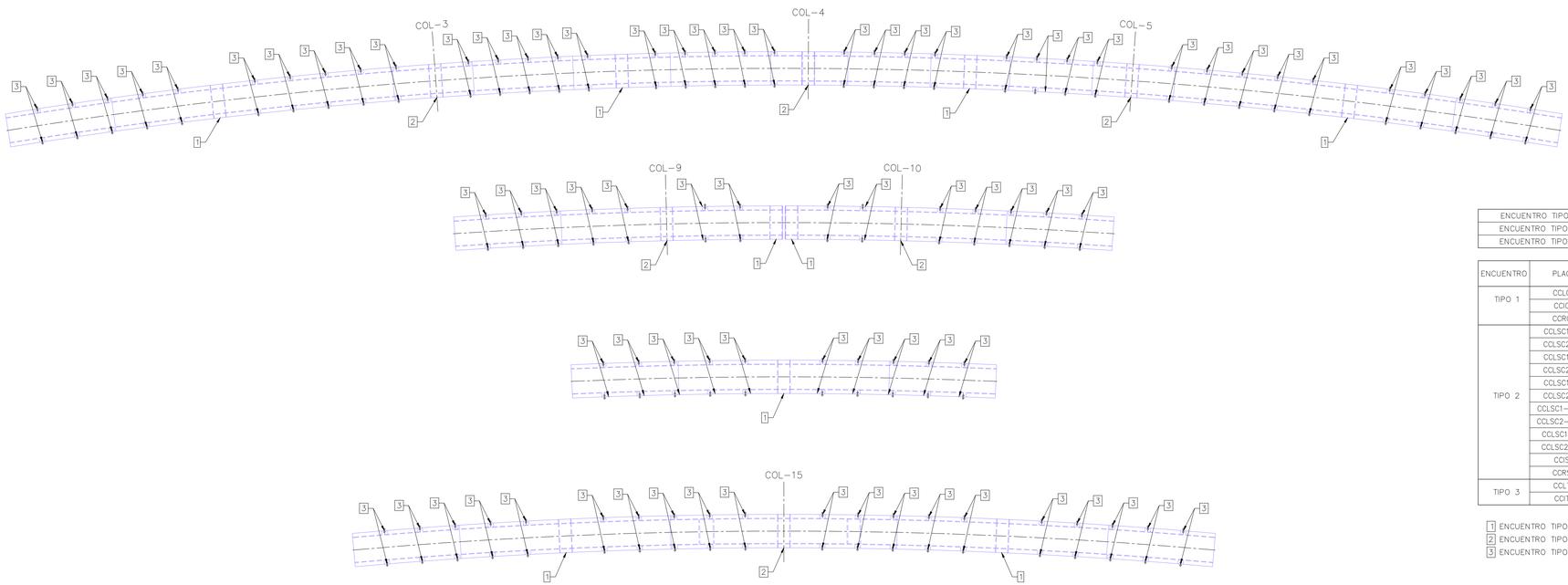


PLACA CCISC
UDS.= 12
ESPESOR= 1"

PLACA CCRSC
UDS.= 12
ESPESOR= 1"



CAJÓN CENTRAL
ESCALA 1:100



	TRAMO 1	TRAMO 2	TRAMO 3	TRAMO 4	TOTAL
ENCUENTRO TIPO 1	8	4	2	4	18
ENCUENTRO TIPO 2	6	4	0	2	12
ENCUENTRO TIPO 3	76	28	20	40	164

ENCUENTRO	PLACA	TRAMO				TOTAL
		TRAMO 1	TRAMO 2	TRAMO 3	TRAMO 4	
TIPO 1	CCLCC	16	8	4	8	36
	CCICC	8	4	2	4	18
	CCRCC	8	4	2	4	18
TIPO 2	CCLSC1-C3	2	0	0	0	2
	CCLSC2-C3	2	0	0	0	2
	CCLSC1-C4	2	0	0	0	2
	CCLSC2-C4	2	0	0	0	2
	CCLSC1-C5	2	0	0	0	2
	CCLSC2-C5	2	0	0	0	2
	CCLSC1-C9/10	0	4	0	0	4
	CCLSC2-C9/10	0	4	0	0	4
	CCLSC1-C15	0	0	0	2	2
	CCLSC2-C15	0	0	0	2	2
	CCISC	6	4	0	2	12
	CORSC	6	4	0	2	12
TIPO 3	CCLTS	76	28	20	40	164
	CCITS	76	28	20	40	164

1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

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	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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DRO-1400

CORRESPONSAL ESTRUCTURAL
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COE-0083

APROBÓ:
M. I. DANIEL PÉREZ BELLO

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M.V.T. GERMÁN GARCÍA DEHEZA

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DIBUJÓ:
M.B.

OBSERVACIONES:

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TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
CAJÓN CENTRAL (I)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

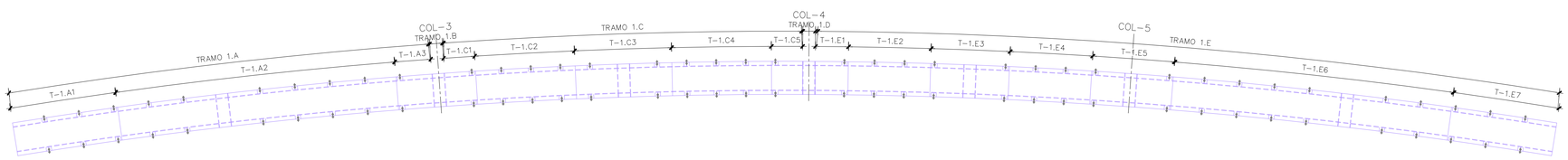
PLANO No: **DGOT-20-EST-III-0087-00288-P-00**

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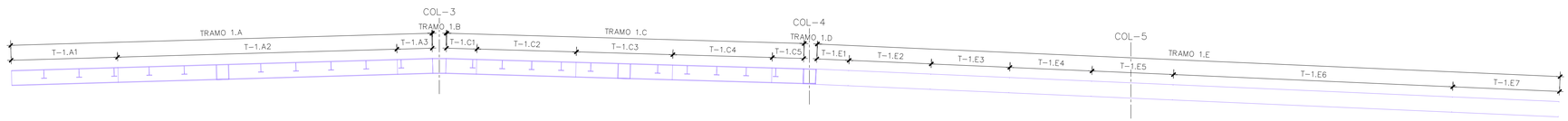
CONTROL	FECHA	DEPTO	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRÁN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0087-00288-P-00



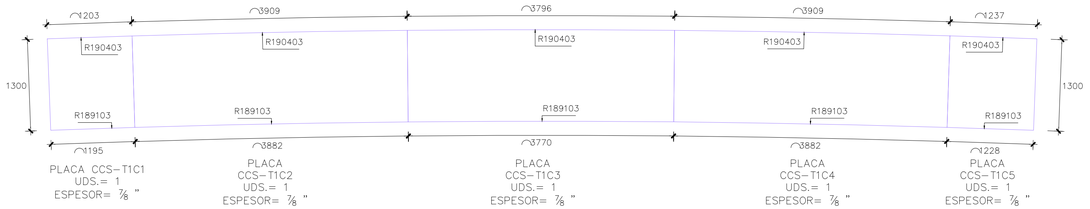
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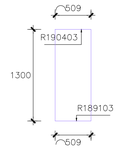
ALZADO

CAJÓN CENTRAL. TRAMO 1

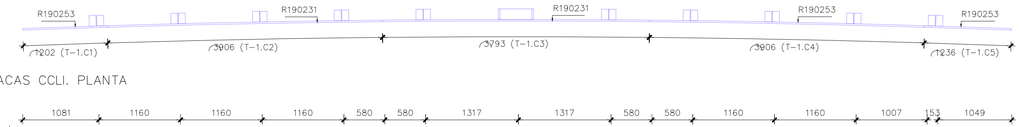
ESCALA 1:100



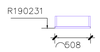
PLACAS CCS. PLANTA



PLACAS CCS. PLANTA

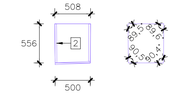


PLACAS CCLI. PLANTA



PLACAS CCLI. PLANTA

PLACAS CCLI. ALZADO DESARROLLADO



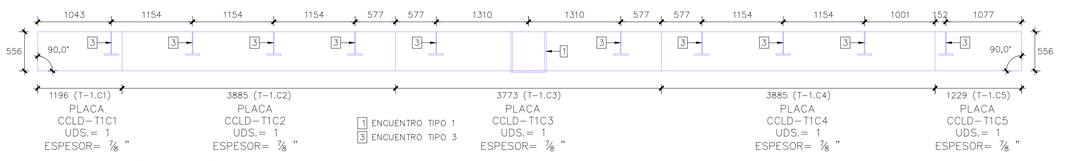
PLACAS CCLI. ALZADO DESARROLLADO



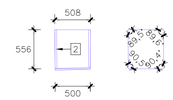
PLACAS CCLD. PLANTA



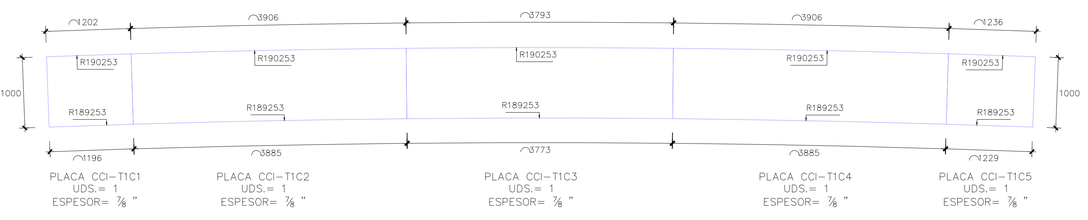
PLACAS CCLD. PLANTA



PLACAS CCLD. ALZADO DESARROLLADO



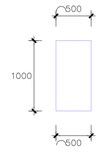
PLACAS CCLD. ALZADO DESARROLLADO



PLACAS CCI. PLANTA

B CAJÓN CENTRAL. TRAMO 1.C

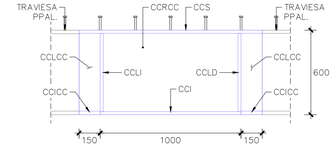
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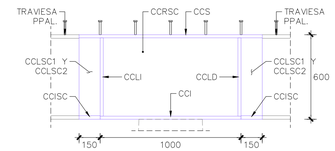


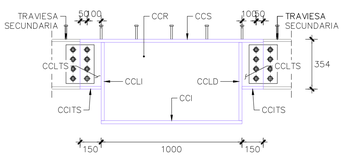
PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 1.

ESCALA 1:40







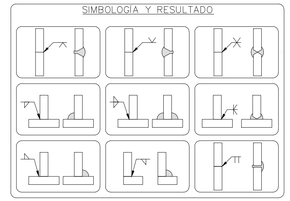
CAJÓN CENTRAL. SECCIONES TRANSVERSALES

ESCALA 1:20

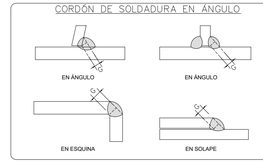
ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

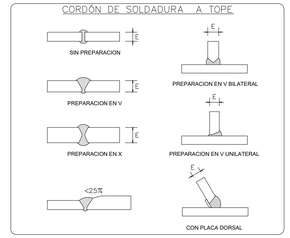
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRISEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRISEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJO:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA
CAJÓN CENTRAL (III)

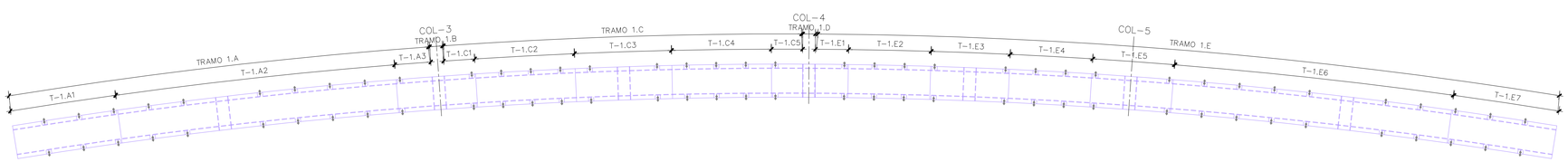
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0089-00290-P-00**

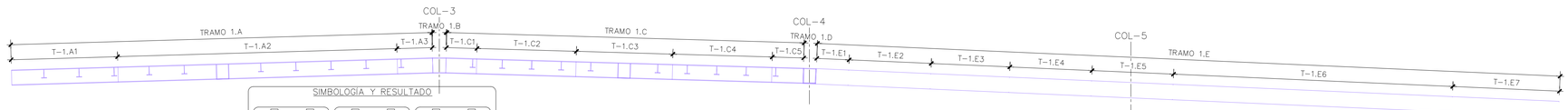
ESCALA GRÁFICA: 0 4 12 7 4

ESCALAS	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:40
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ESC:
					ACOT: METROS

DGOT-20-EST-III-0089-00290-P-00

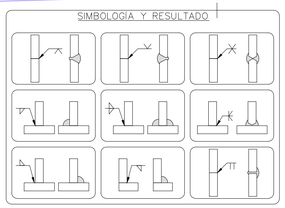


PLANTA



ALZADO

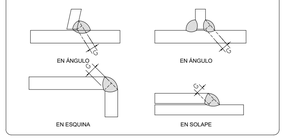
SIMBOLOGÍA Y RESULTADO



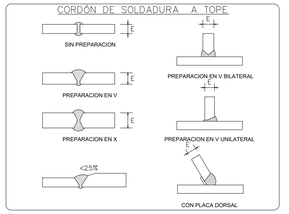
CAJÓN CENTRAL. TRAMO 1

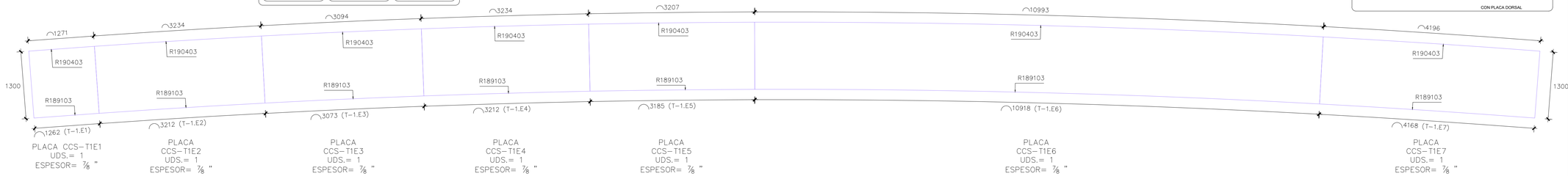
ESCALA 1:100

CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





PLACA CCS-T1E1
UDS.= 1
ESPESOR= 7/8 "

PLACA CCS-T1E2
UDS.= 1
ESPESOR= 7/8 "

PLACA CCS-T1E3
UDS.= 1
ESPESOR= 7/8 "

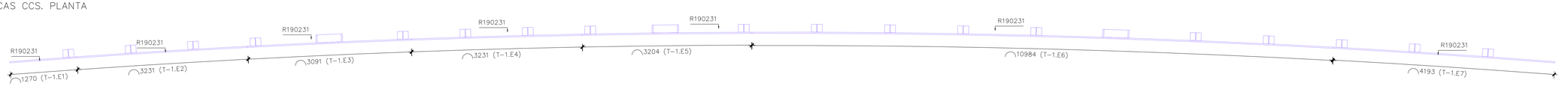
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UDS.= 1
ESPESOR= 7/8 "

PLACA CCS-T1E5
UDS.= 1
ESPESOR= 7/8 "

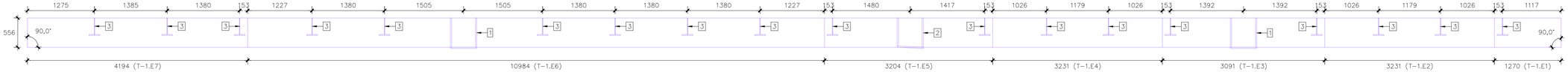
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UDS.= 1
ESPESOR= 7/8 "

PLACA CCS-T1E7
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCS. PLANTA



PLACAS CCLI. PLANTA



1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

PLACA CCLI-T1E7
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLI-T1E6
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLI-T1E5
UDS.= 1
ESPESOR= 7/8 "

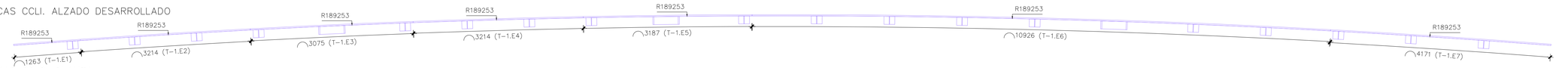
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UDS.= 1
ESPESOR= 7/8 "

PLACA CCLI-T1E3
UDS.= 1
ESPESOR= 7/8 "

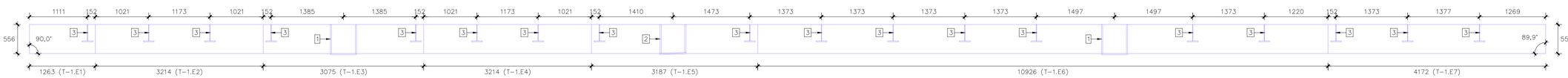
PLACA CCLI-T1E2
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLI-T1E1
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLI. ALZADO DESARROLLADO



PLACAS CCLD. PLANTA



1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

PLACA CCLD-T1E1
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLD-T1E2
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLD-T1E3
UDS.= 1
ESPESOR= 7/8 "

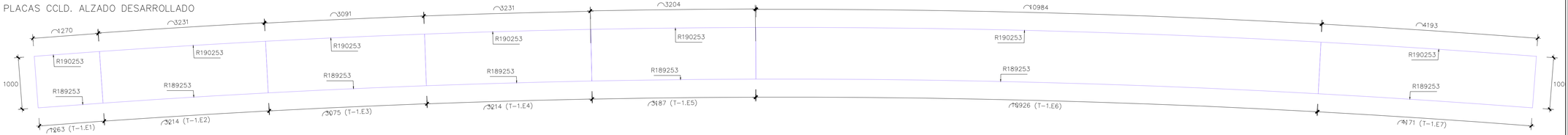
PLACA CCLD-T1E4
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLD-T1E5
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLD-T1E6
UDS.= 1
ESPESOR= 7/8 "

PLACA CCLD-T1E7
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLD. ALZADO DESARROLLADO



PLACA CCI-T1E1
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T1E2
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T1E3
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T1E4
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T1E5
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T1E6
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T1E7
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 1.E

ESCALA 1:40

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0065

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA CAJÓN CENTRAL (IV)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

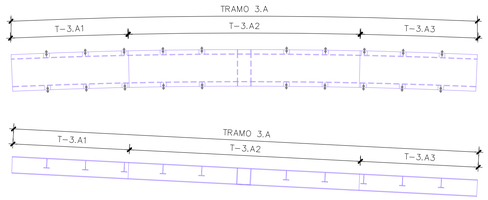
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ESCALA GRÁFICA: 0 1 2 3 4 5

REVISÓ	FECHA	DEPTO	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD. 1:40
FECHA: JULIO 2021
ESC.
ACOT.: METROS

DGOT-20-EST-III-0090-00291-P-00

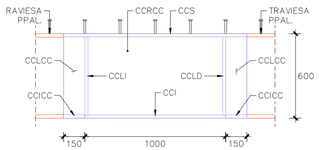


PLANTA

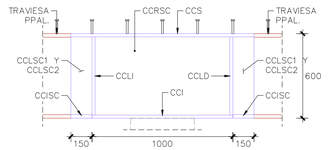
ALZADO

CAJÓN CENTRAL. TRAMO 3

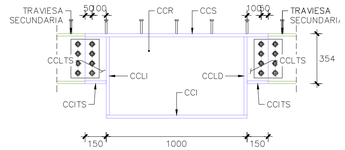
ESCALA 1:100



ENCUENTRO TIPO 1
ENCUENTRO CON TRAVIESA PPAL.
CENTRO DE CLARO



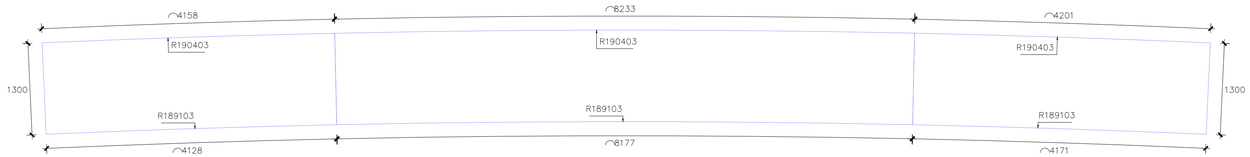
ENCUENTRO TIPO 2
ENCUENTRO CON TRAVIESA PPAL.
SOBRE COLUMNA



ENCUENTRO TIPO 3
ENCUENTRO CON TRAVIESA
SECUNDARIA

CAJÓN CENTRAL. SECCIONES TRANSVERSALES

ESCALA 1:20

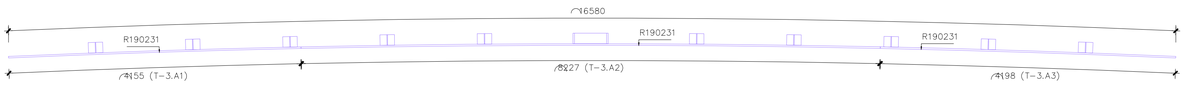


PLACA
CCS-T3A1
UDS.= 1
ESPESOR= 7/8 "

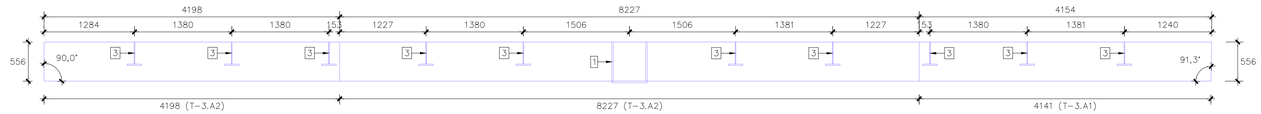
PLACA
CCS-T3A2
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCS-T3A3
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCS. PLANTA



PLACAS CCLI. PLANTA



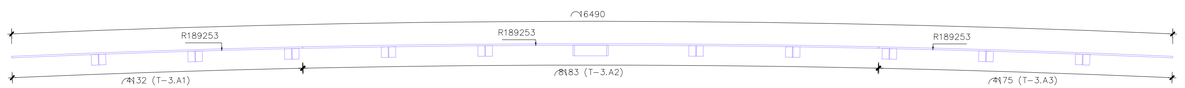
4198 (T-3.A2)
PLACA
CCLI-T3A3
UDS.= 1
ESPESOR= 7/8 "

8227 (T-3.A2)
PLACA
CCLI-T3A2
UDS.= 1
ESPESOR= 7/8 "

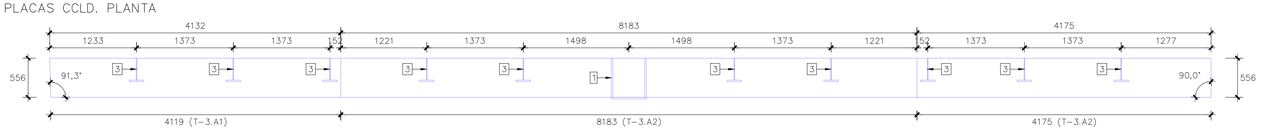
4141 (T-3.A1)
PLACA
CCLI-T3A1
UDS.= 1
ESPESOR= 7/8 "

1 ENCUENTRO TIPO 1
3 ENCUENTRO TIPO 3

PLACAS CCLI. ALZADO DESARROLLADO



PLACAS CCLD. PLANTA



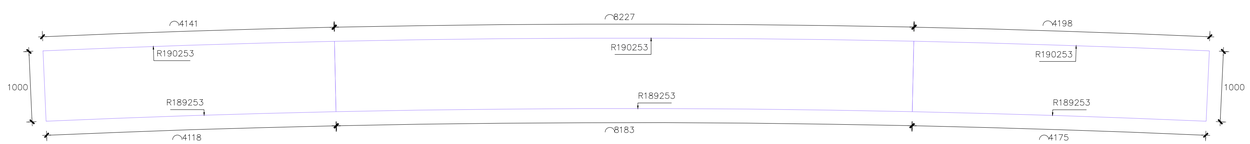
4119 (T-3.A1)
PLACA
CCLD-T3A1
UDS.= 1
ESPESOR= 7/8 "

8183 (T-3.A2)
PLACA
CCLD-T3A2
UDS.= 1
ESPESOR= 7/8 "

4175 (T-3.A2)
PLACA
CCLD-T3A3
UDS.= 1
ESPESOR= 7/8 "

1 ENCUENTRO TIPO 1
3 ENCUENTRO TIPO 3

PLACAS CCLD. ALZADO DESARROLLADO



PLACA CCI-T3A1
UDS.= 1
ESPESOR= 7/8 "

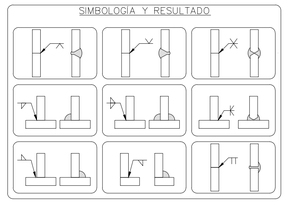
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UDS.= 1
ESPESOR= 7/8 "

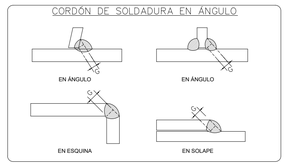
PLACA CCI-T3A3
UDS.= 1
ESPESOR= 7/8 "

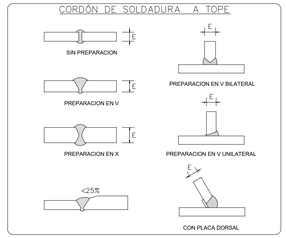
PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 3.A

ESCALA 1:40







ACERO ESTRUCTURAL

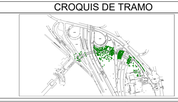
– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FIDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1450

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CISE-0085

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
CAJÓN CENTRAL (VI)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

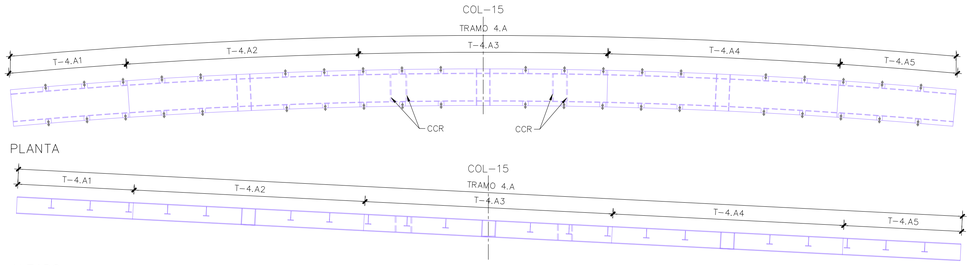
PLANO No: **DGOT-20-EST-III-0092-00293-P-00**

ESCALA GRÁFICA: 0 4 12 8 4

CONTROL	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

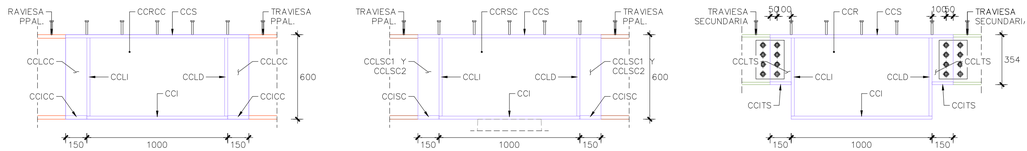
MOD: 1:40
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0092-00293-P-00



CAJÓN CENTRAL. TRAMO 4

ESCALA 1:100



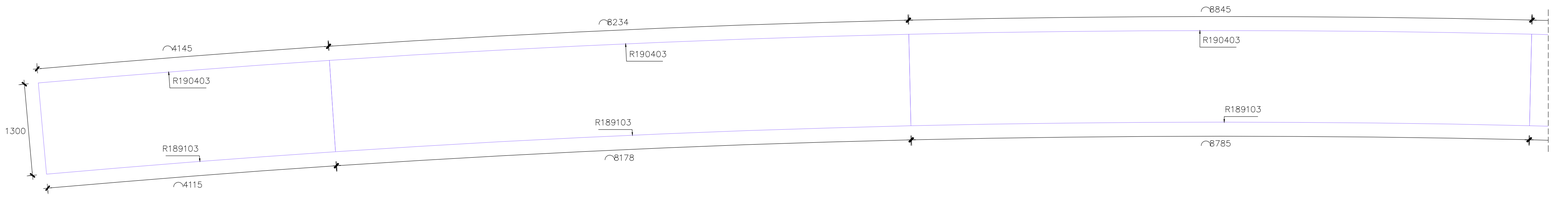
ENCUENTRO TIPO 1
ENCUENTRO CON TRAVIESA PPAL.
CENTRO DE CLARO

ENCUENTRO TIPO 2
ENCUENTRO CON TRAVIESA PPAL.
SOBRE COLUMNA

ENCUENTRO TIPO 3
ENCUENTRO CON TRAVIESA SECUNDARIA

CAJÓN CENTRAL. SECCIONES TRANSVERSALES

ESCALA 1:20

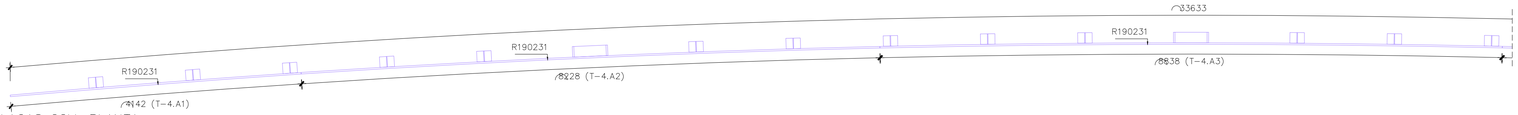


PLACA
CCS-T4A1
UDS.= 1
ESPESOR= 7/8 "

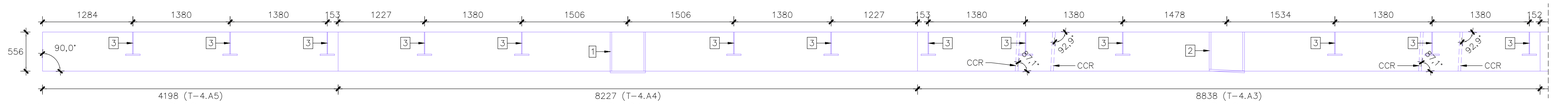
PLACA
CCS-T4A2
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCS-T4A3
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCS. PLANTA



PLACAS CCLI. PLANTA

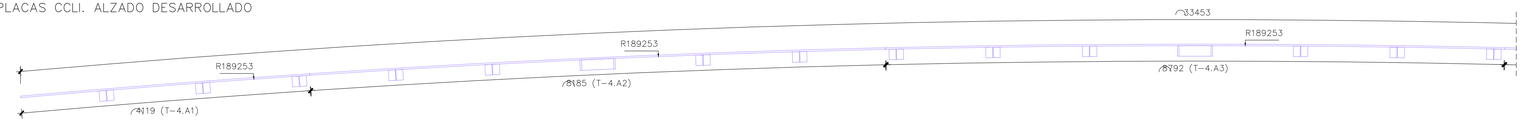


4198 (T-4.A5)
PLACA
CCLI-T4A5
UDS.= 1
ESPESOR= 7/8 "

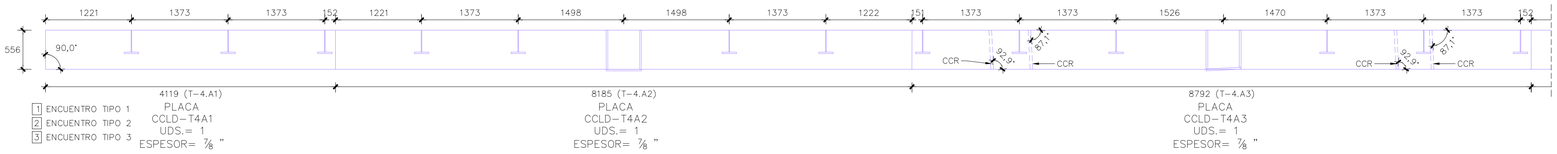
8227 (T-4.A4)
PLACA
CCLI-T4A4
UDS.= 1
ESPESOR= 7/8 "

8838 (T-4.A3)
PLACA
CCLI-T4A3
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLI. ALZADO DESARROLLADO



PLACAS CCLD. PLANTA

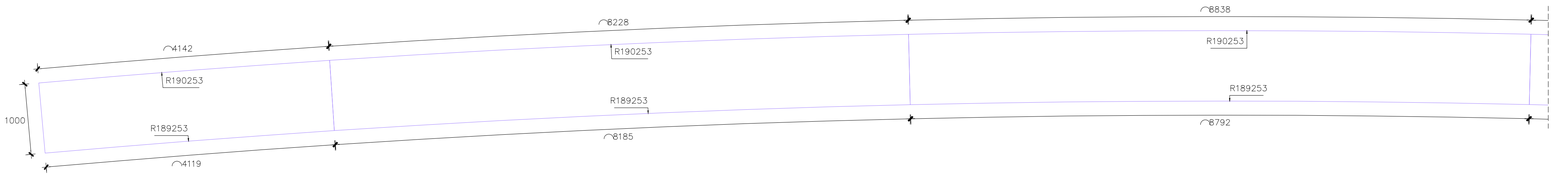


4119 (T-4.A1)
PLACA
CCLD-T4A1
UDS.= 1
ESPESOR= 7/8 "

8185 (T-4.A2)
PLACA
CCLD-T4A2
UDS.= 1
ESPESOR= 7/8 "

8792 (T-4.A3)
PLACA
CCLD-T4A3
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLD. ALZADO DESARROLLADO



PLACA CCI-T4A1
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T4A2
UDS.= 1
ESPESOR= 7/8 "

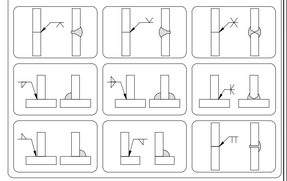
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UDS.= 1
ESPESOR= 7/8 "

PLACAS CCI. PLANTA

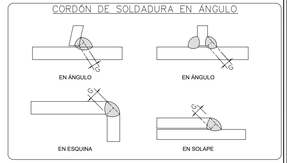
CAJÓN CENTRAL. TRAMO 4.A

ESCALA 1:40

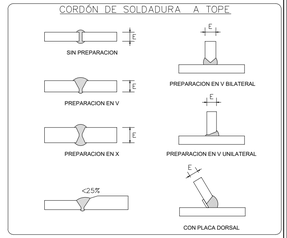
SIMBOLOGÍA Y RESULTADO

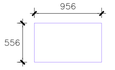


CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE





PLACA CCR
UDS.= 4
ESPESOR=1 1/2 "

PLACAS CCR

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FRIDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED. PROF.

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA METÁLICA
CAJÓN CENTRAL (VIII)

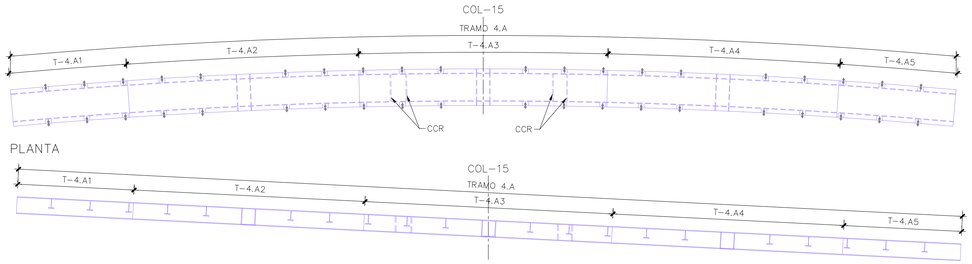
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0093-00294-P-00**

ESCALA GRÁFICA: 0 4 12 20 40

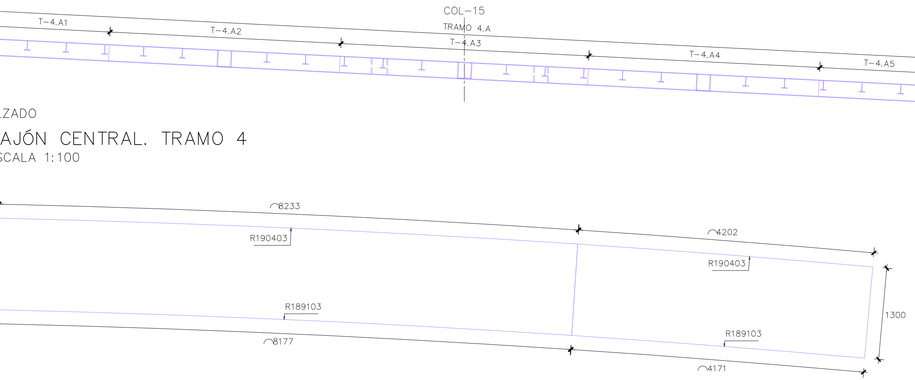
FECHA	DEPTO.	NOMBRE	FIRMA	
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:40
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT: METROS

DGOT-20-EST-III-0093-00294-P-00



CAJÓN CENTRAL. TRAMO 4

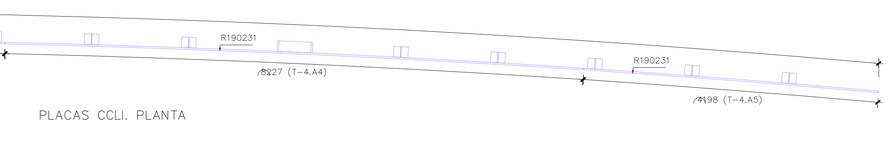
ESCALA 1:100



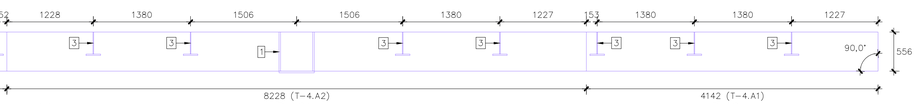
PLACA
CCS-T4A4
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCS-T4A5
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCS. PLANTA



PLACAS CCLI. PLANTA

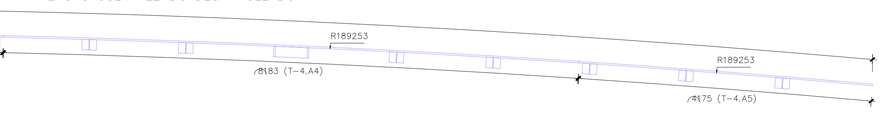


1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

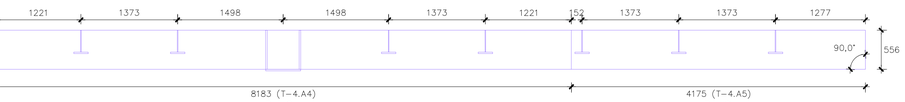
PLACA
CCLI-T4A2
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLI-T4A1
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLI. ALZADO DESARROLLADO



PLACAS CCLD. PLANTA

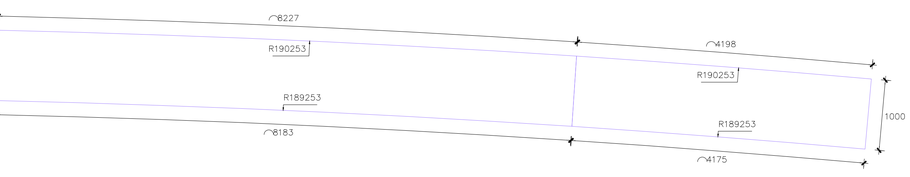


1 ENCUENTRO TIPO 1
2 ENCUENTRO TIPO 2
3 ENCUENTRO TIPO 3

PLACA
CCLD-T4A4
UDS.= 1
ESPESOR= 7/8 "

PLACA
CCLD-T4A5
UDS.= 1
ESPESOR= 7/8 "

PLACAS CCLD. ALZADO DESARROLLADO



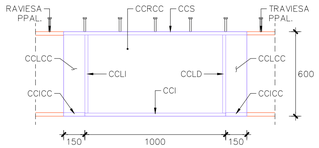
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CCI-T4A4
UDS.= 1
ESPESOR= 7/8 "

PLACA CCI-T4A5
UDS.= 1
ESPESOR= 7/8 "

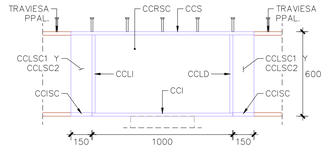
PLACAS CCI. PLANTA

CAJÓN CENTRAL. TRAMO 4.A

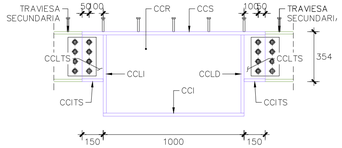
ESCALA 1:40



ENCUENTRO TIPO 1
ENCUENTRO CON TRAVIESA PPAL.
CENTRO DE CLARO



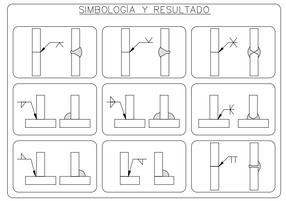
ENCUENTRO TIPO 2
ENCUENTRO CON TRAVIESA PPAL.
SOBRE COLUMNA

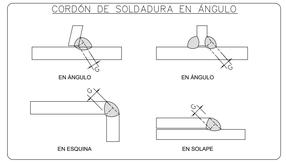


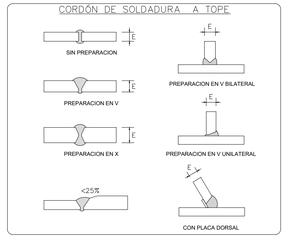
ENCUENTRO TIPO 3
ENCUENTRO CON TRAVIESA
SECUNDARIA

CAJÓN CENTRAL. SECCIONES TRANSVERSALES

ESCALA 1:20







ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN-AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR UNICO FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1488

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE 1488

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO. ESTRUCTURA MIETÁLICA
CAJÓN CENTRAL (VIII)

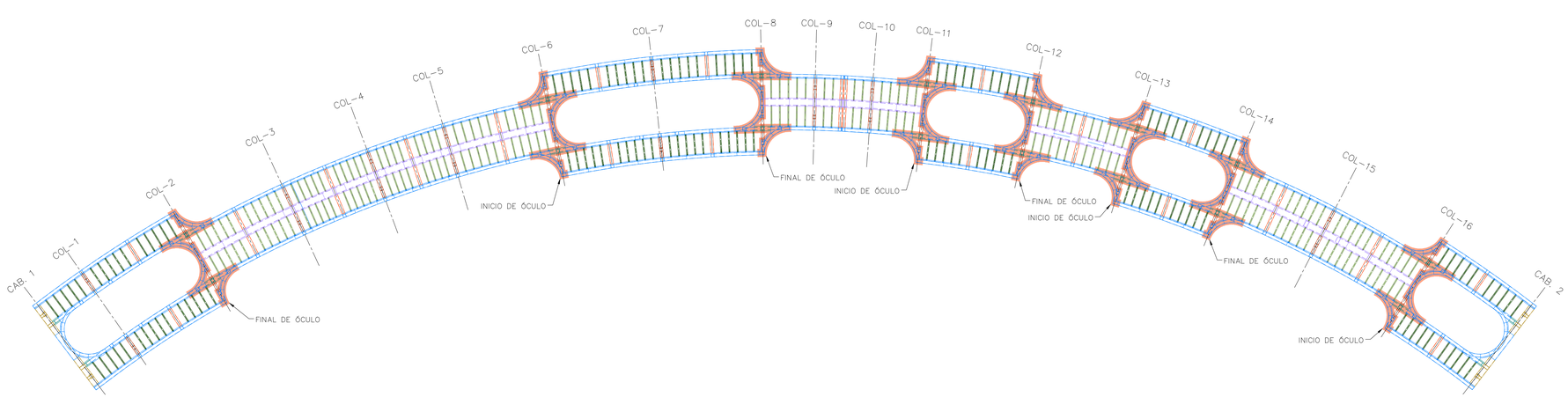
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: DGOT-20-EST-III-0094-00295-P-00

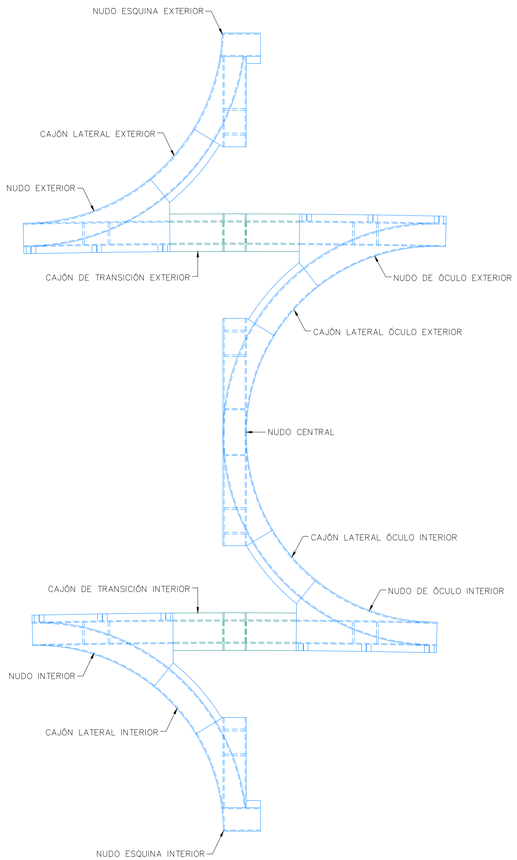
ESCALA GRÁFICA: 0 4 12 7 4

ESTUDIO	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:40
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

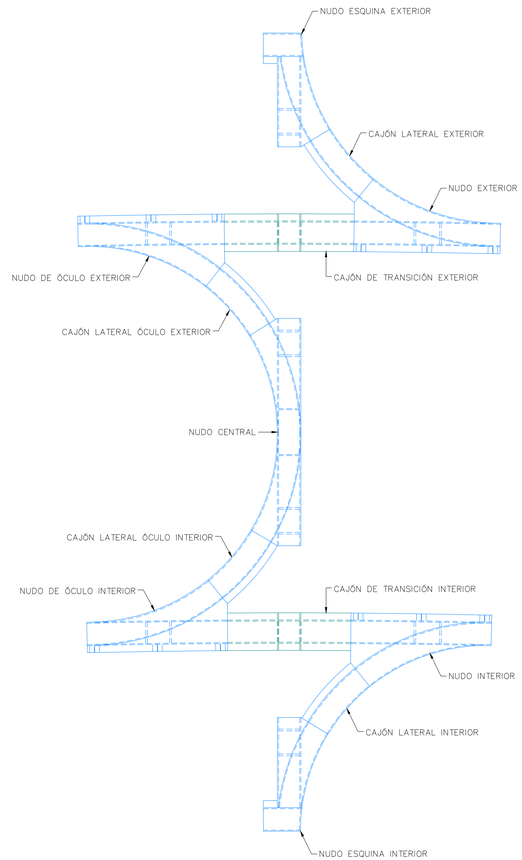
DGOT-20-EST-III-0094-00295-P-00



ZONAS DE TRANSICIÓN. PLANTA GENERAL
ESCALA 1:400

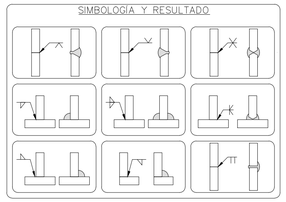


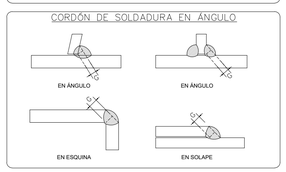
NUDOS INICIO DE ÓCULO

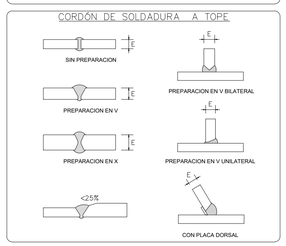


NUDOS FINAL DE ÓCULO

IDENTIFICACIÓN DE NUDOS EN ZONA DE TRANSICIÓN
ESCALA 1:60







IMPORTANTE

- LA GEOMETRÍA DE LOS NUDOS INDICADOS ES SÍMETRICA ENTRE SÍ PARA INICIO Y FINAL DE ÓCULO, POR LO QUE SOLAMENTE SE DETALLARÁ LA GEOMETRÍA DE LAS PLACAS DE LOS NUDOS DE INICIO DE ÓCULO, SIENDO EL MONTAJE DE LAS MISMAS SÍMETRICO EN LOS NUDOS DE FINAL DE ÓCULO.
- SE DETALLARÁ LA GEOMETRÍA DE LAS PLACAS VARIABLES, YA SEAN DE INICIO O FINAL DE ÓCULO.
- EL MONTAJE DE LAS DIFERENTES PLACAS QUE COMPONEN EL NUDO ES EQUIVALENTE EN LOS SIGUIENTES NUDOS:
  - NUDO ESQUINA EXTERIOR ≡ NUDO ESQUINA INTERIOR
  - CAJÓN LATERAL EXTERIOR ≡ CAJÓN LATERAL ÓCULO EXTERIOR ≡ CAJÓN LATERAL ÓCULO INTERIOR ≡ CAJÓN LATERAL INTERIOR
  - NUDO EXTERIOR ≡ NUDO DE ÓCULO EXTERIOR ≡ NUDO DE ÓCULO INTERIOR ≡ NUDO INTERIOR
  - CAJÓN DE TRANSICIÓN EXTERIOR ≡ CAJÓN DE TRANSICIÓN INTERIOR

ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN


CROQUIS DE TRAMO


SIMBOLOGÍA

NOTAS GENERALES
1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
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PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CPD-1485

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CPD-1995

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN GENERAL

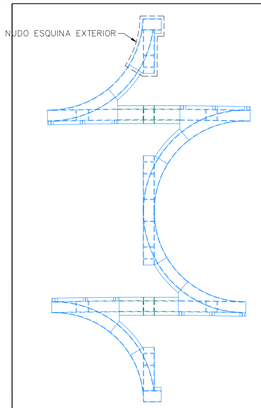
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

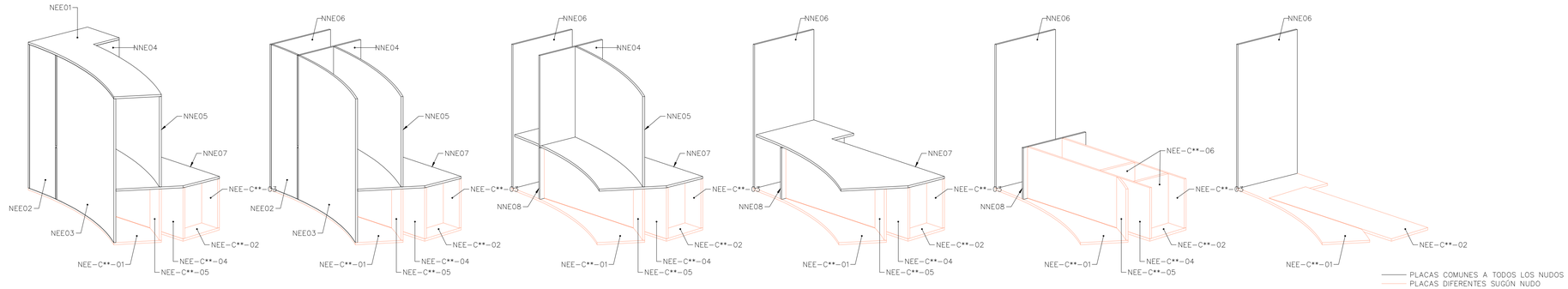
PLANO No.: **DGOT-20-EST-III-0095-00296-P-00**

ESCALA GRÁFICA: 0 2 4 6 8 10

ESTADO	FECHA	DEPTO	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INCENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC.
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ		ACOT. METROS

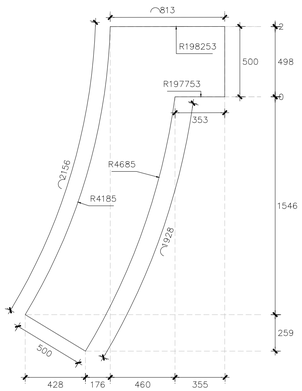
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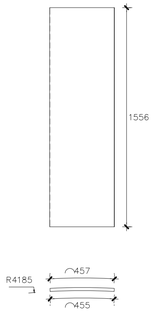


NUDOS INICIO DE ÓCULO. PLANTA
ESCALA 1:125

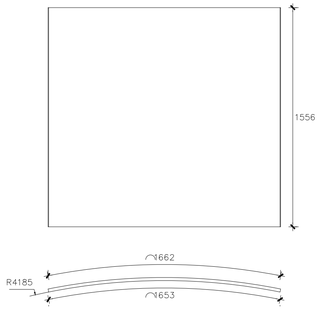
NUDO ESQUINA EXTERIOR. PERSPECTIVAS
SIN ESCALA



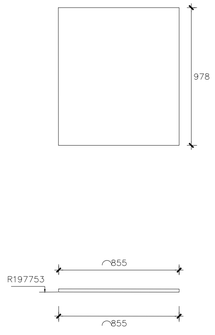
PLACA NEE01
UDS.= 8
ESPESOR= 7/8 "



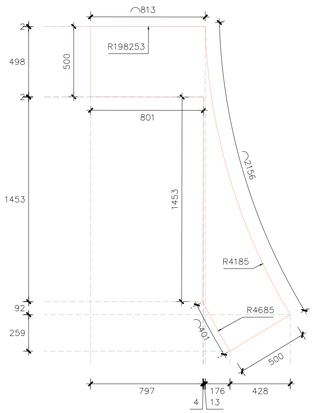
PLACA NEE02
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ESPESOR= 7/8 "



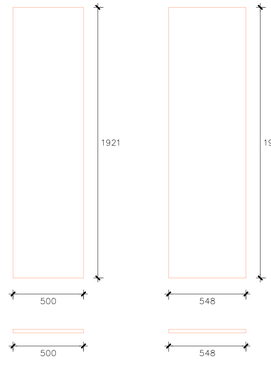
PLACA NEE03
UDS.= 8
ESPESOR= 7/8 "



PLACA NEE04
UDS.= 8
ESPESOR= 7/8 "



PLACA NEE-C02-01
UDS.= 1
ESPESOR= 7/8 "

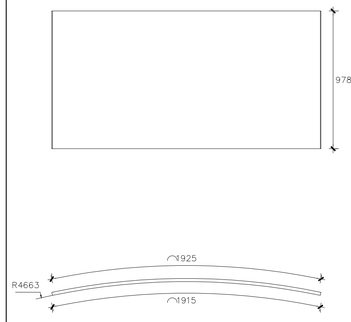


PLACA NEE-C02-02
UDS.= 1
ESPESOR=1 "

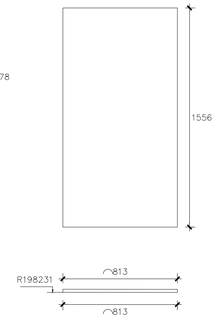
PLACA NEE-C02-03
UDS.= 1
ESPESOR=1 "



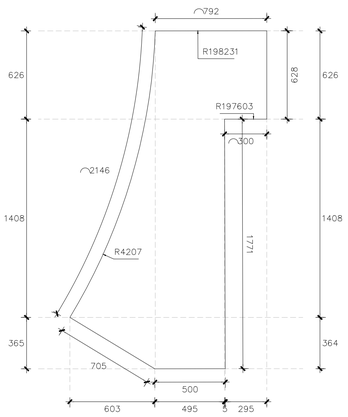
PLACA NEE-C02-04
UDS.= 1
ESPESOR=1 "



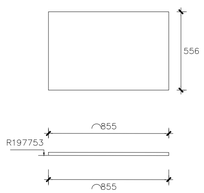
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ESPESOR= 7/8 "



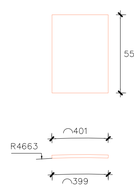
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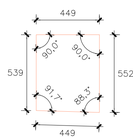
PLACA NEE07
UDS.= 8
ESPESOR= 7/8 "



PLACA NEE08
UDS.= 8
ESPESOR= 7/8 "



PLACA NEE-C02-05
UDS.= 1
ESPESOR= 7/8 "



PLACA NEE-C02-06
UDS.= 2
ESPESOR= 1 ½ "

NUDO ESQUINA EXTERIOR. DESPICE DE PLACAS COMUNES
ESCALA 1:20

NUDO ESQUINA EXTERIOR EN COLUMNA C-02

NUDO ESQUINA EXTERIOR. DESPICE DE PLACAS VARIABLES
ESCALA 1:20

SIMBOLOGÍA Y RESULTADO

CORDÓN DE SOLDADURA EN ÁNGULO

CORDÓN DE SOLDADURA A TOPE

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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PLANOS DE REFERENCIA

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NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA:
ING. ARQ. EDMUNDO REYES MADRID
DRO-1485

CORRESPONSAL ESTRUCTURAL:
ING. LUCIO RAMÓN MONTERO OROZCO
CDE-0685

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (I)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

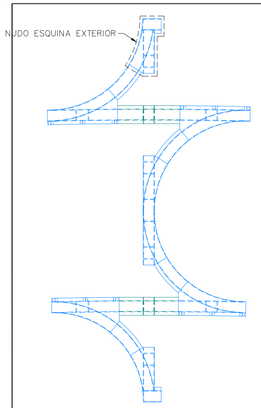
PLANO No.
DGOT-20-EST-III-0096-00297-P-00

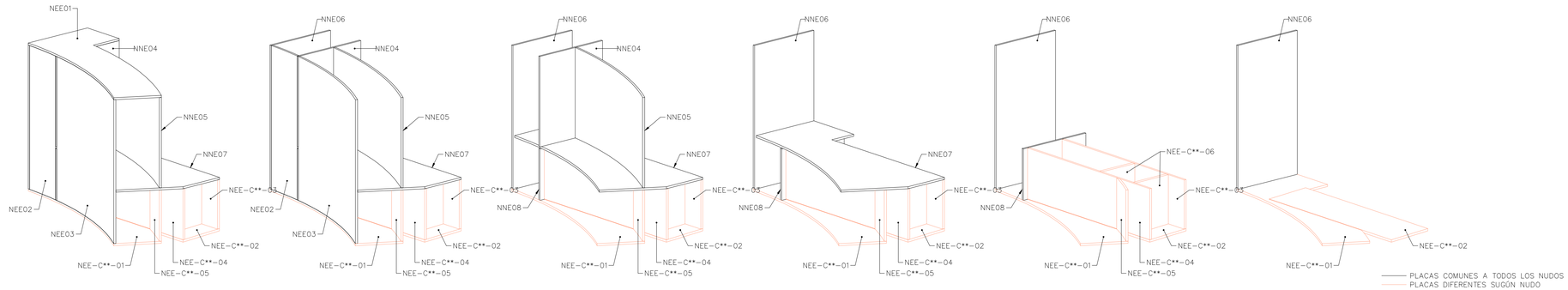
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FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

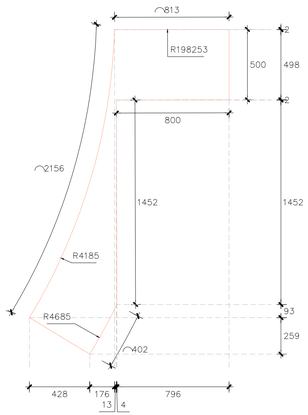
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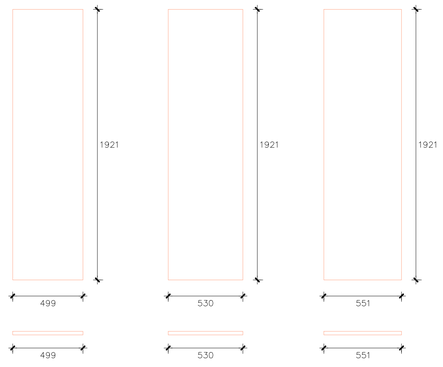


NUDOS INICIO DE ÓCULO. PLANTADO ESQUINA EXTERIOR. PERSPECTIVAS

ESCALA 1:125 SIN ESCALA



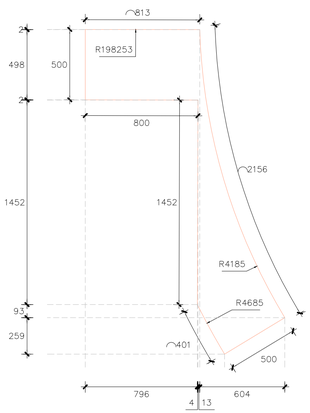
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UDS.= 1
ESPESOR= ⅞ "



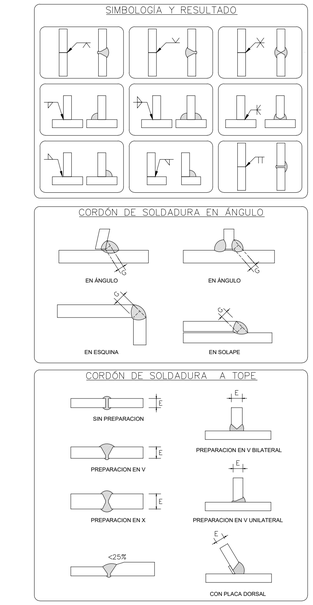
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UDS.= 1
ESPESOR=1 "

PLACA NEE-C06-03
UDS.= 1
ESPESOR=1 "

PLACA NEE-C06-04
UDS.= 1
ESPESOR=1 "

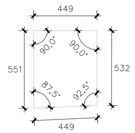


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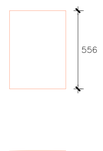


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ESPESOR= ⅞ "

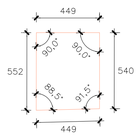


PLACA NEE-C06-06
UDS.= 2
ESPESOR= 1 ½ "

NUDO ESQUINA EXTERIOR EN COLUMNA C-06

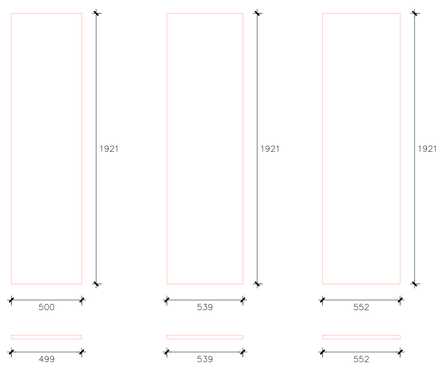


PLACA NEE-C08-05
UDS.= 1
ESPESOR= ⅞ "



PLACA NEE-C08-06
UDS.= 2
ESPESOR= 1 ½ "

NUDO ESQUINA EXTERIOR EN COLUMNA C-08



PLACA NEE-C08-02
UDS.= 1
ESPESOR=1 "

PLACA NEE-C08-03
UDS.= 1
ESPESOR=1 "

PLACA NEE-C08-04
UDS.= 1
ESPESOR=1 "

NUDO ESQUINA EXTERIOR. DESPICE DE PLACAS VARIABLES

ESCALA 1:20

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FIEDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR UNICO
FIEDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1600

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CRE 10855

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA NUDOS EN ZONAS DE ÓCULOS DEFINICIÓN DE NUDOS (II)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

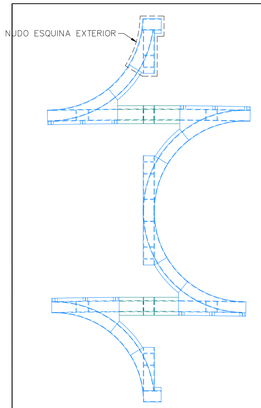
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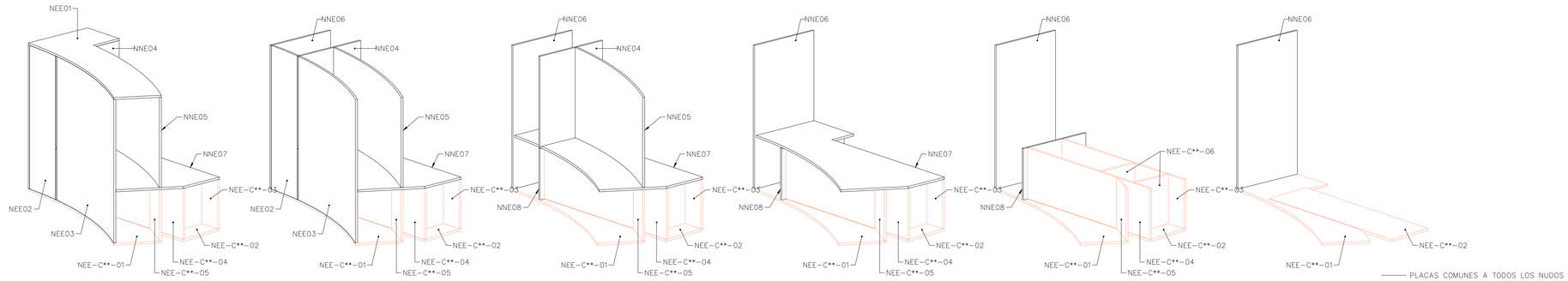
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FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO ESTRUCTURA	M.I. INOCENCIO MALDONADO TORRES	
	ARQUITECTURA	M.I. ARGEL RAMOS CAPISTRAN	
		M.C.A. JESUS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

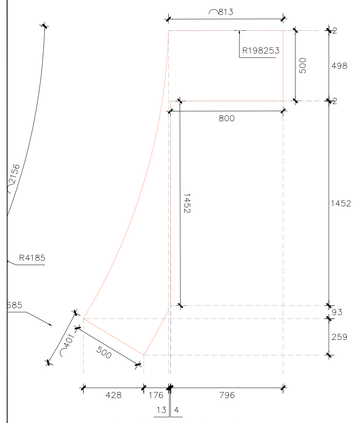
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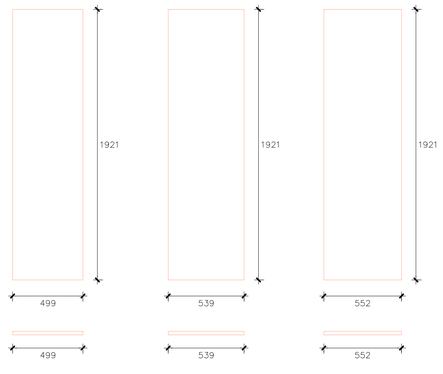


NUDOS INICIO DE ÓCULO. PLANTA
ESCALA 1:125

NUDO ESQUINA EXTERIOR. PERSPECTIVAS
SIN ESCALA



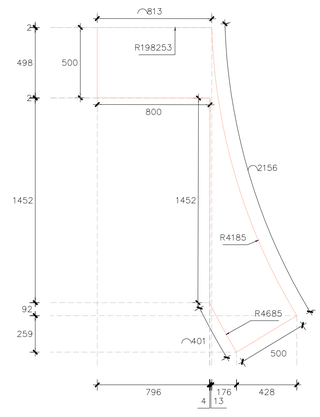
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UDS.= 1
ESPESOR= 7/8 "



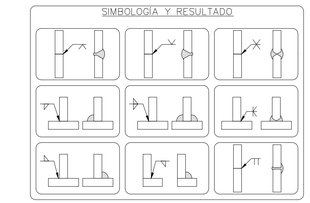
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UDS.= 1
ESPESOR=1 "

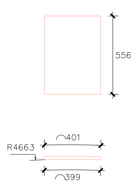
PLACA NEE-C11-03
UDS.= 1
ESPESOR=1 "

PLACA NEE-C11-04
UDS.= 1
ESPESOR=1 "

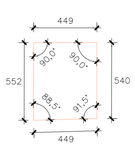


PLACA NEE-C12-01
UDS.= 1
ESPESOR= 7/8 "

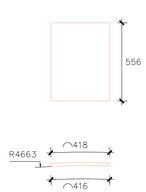




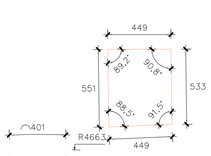
PLACA NEE-C11-05
UDS.= 1
ESPESOR= 7/8 "



PLACA NEE-C11-06
UDS.= 2
ESPESOR= 1 1/2 "



PLACA NEE-C12-05
UDS.= 1
ESPESOR= 7/8 "

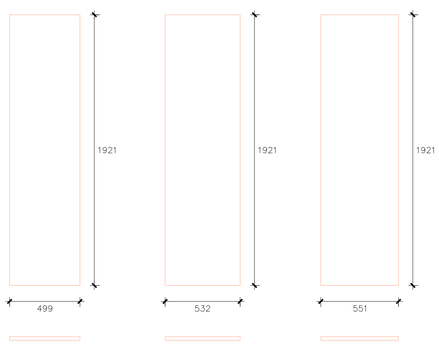


PLACA NEE-C12-06
UDS.= 2
ESPESOR= 1 1/2 "

NUDO ESQUINA EXTERIOR EN COLUMNA C-11

NUDO ESQUINA EXTERIOR EN COLUMNA C-12

NUDO ESQUINA EXTERIOR. DESPICE DE PLACAS VARIABLES
ESCALA 1:20



PLACA NEE-C12-02
UDS.= 1
ESPESOR=1 "

PLACA NEE-C12-03
UDS.= 1
ESPESOR=1 "

PLACA NEE-C12-04
UDS.= 1
ESPESOR=1 "

ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN-AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
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PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A. DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1961

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COR-0065

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (III)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

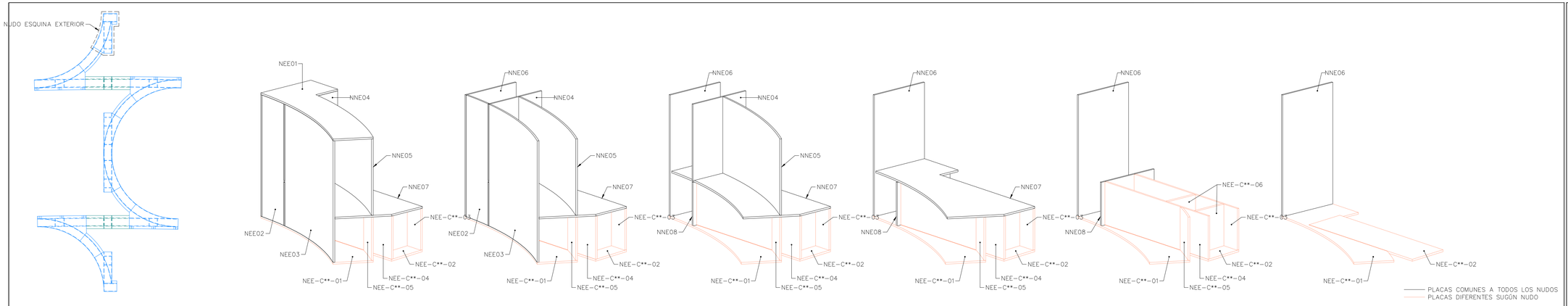
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DGOT-20-EST-III-0098-00299-P-00

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	FECHA:	DEPTO.:	NOMBRE:	FIRMA:
DISEÑO		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

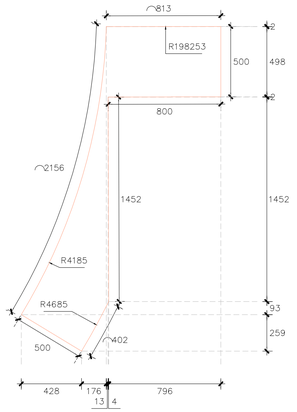
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FECHA: JULIO 2021
ESC.:
ACOT.: METROS

DGOT-20-EST-III-0098-00299-P-00

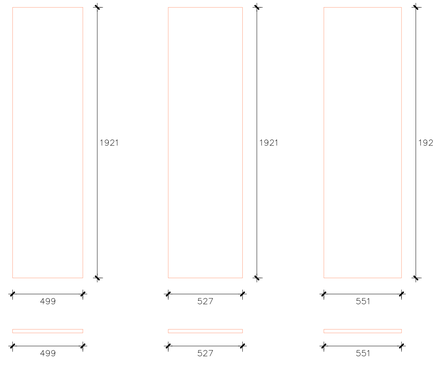


NUDOS INICIO DE ÓCULO. PLANTA
ESCALA 1:125

NUDO ESQUINA EXTERIOR. PERSPECTIVAS
SIN ESCALA



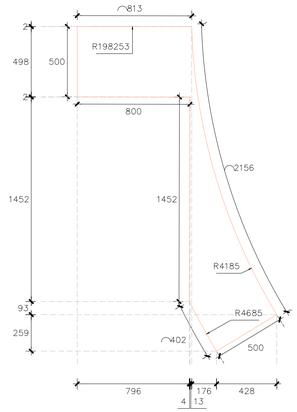
PLACA NEE-C13/16-01
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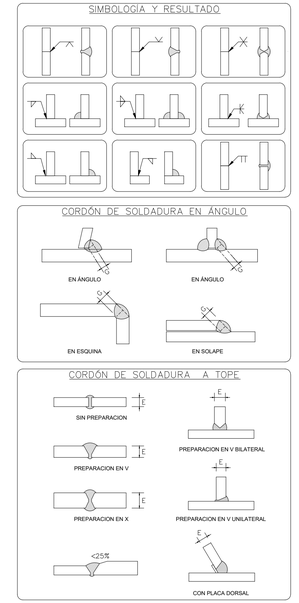
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ESPESOR=1 "

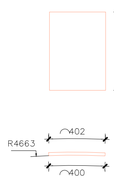
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UDS.= 1
ESPESOR=1 "

PLACA NEE-C13/16-04
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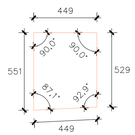


PLACA NEE-C14-01
UDS.= 1
ESPESOR= ⅞ "





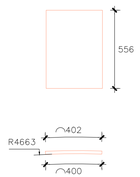
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ESPESOR= ⅞ "



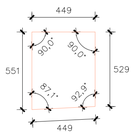
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UDS.= 2
ESPESOR= 1 ½ "

NUDO ESQUINA EXTERIOR EN COLUMNA C-13/16

NUDO ESQUINA EXTERIOR. DESPICE DE PLACAS VARIABLES
ESCALA 1:20

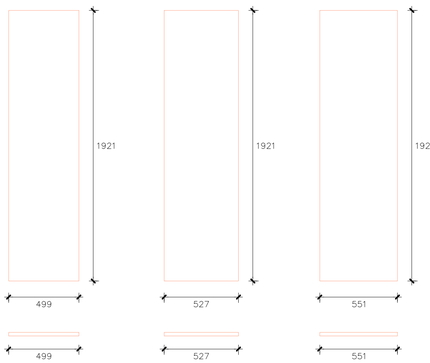


PLACA NEE-C14-05
UDS.= 1
ESPESOR= ⅞ "



PLACA NEE-C14-06
UDS.= 2
ESPESOR= 1 ½ "

NUDO ESQUINA EXTERIOR EN COLUMNA C-14



PLACA NEE-C14-02
UDS.= 1
ESPESOR=1 "

PLACA NEE-C14-03
UDS.= 1
ESPESOR=1 "

PLACA NEE-C14-04
UDS.= 1
ESPESOR=1 "

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA:
ING. ARQ. EDMUNDO REYES MADRID
DRO-1485

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
COE-0585

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (IV)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

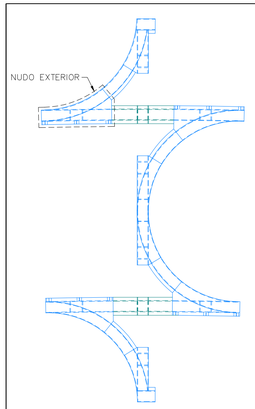
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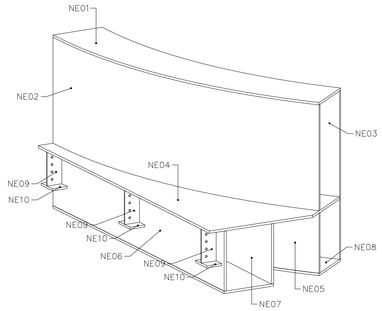
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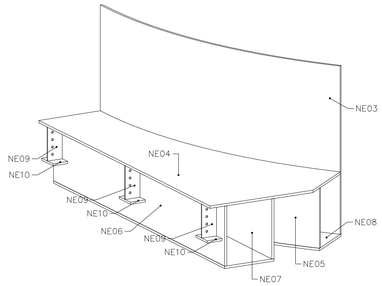
DISEÑO	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

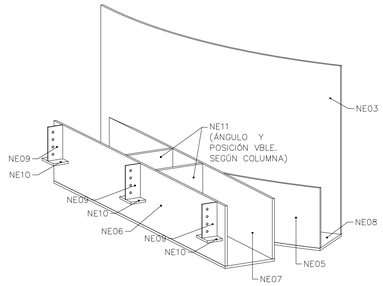
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FECHA: JULIO 2021
ESC:
ACOT: METROS

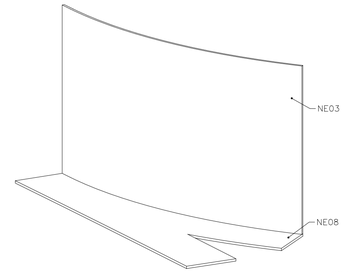
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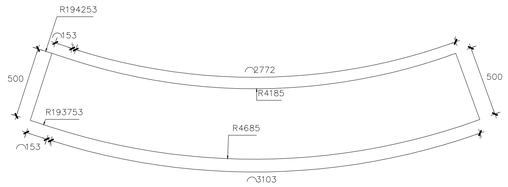




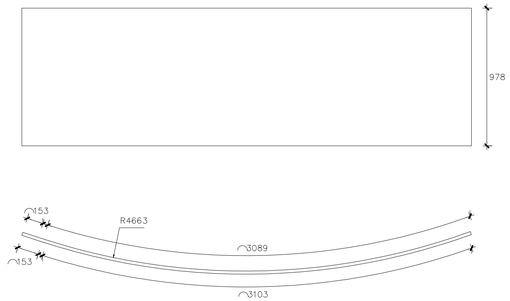
PLACAS COMUNES A TODOS LOS NUDOS

NUDOS INICIO DE ÓCULO. PLANTA
ESCALA 1:125

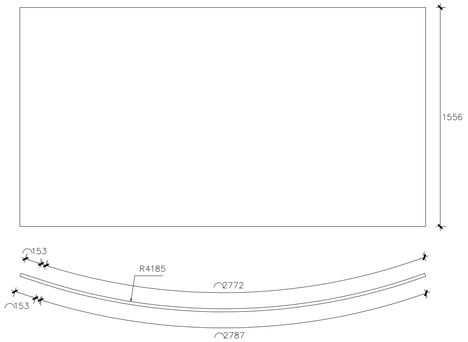
NUDO EXTERIOR. PERSPECTIVAS
SIN ESCALA



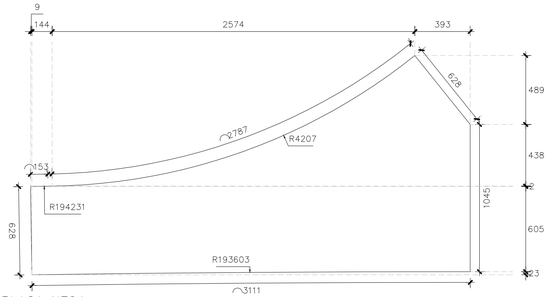
PLACA NE01
UDS.= 8
ESPESOR= 7/8 "



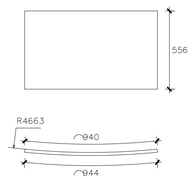
PLACA NE02
UDS.= 8
ESPESOR= 7/8 "



PLACA NE03
UDS.= 8
ESPESOR= 7/8 "



PLACA NE04
UDS.= 8
ESPESOR= 7/8 "

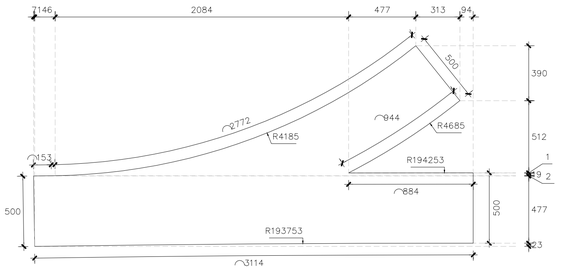


PLACA NE05
UDS.= 8
ESPESOR= 7/8 "

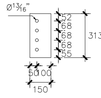


PLACA NE06
UDS.= 8
ESPESOR= 7/8 "

PLACA NE07
UDS.= 8
ESPESOR= 7/8 "



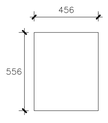
PLACA NE08
UDS.= 8
ESPESOR= 7/8 "



PLACA NE09
UDS.= 24
ESPESOR= 3/8 "

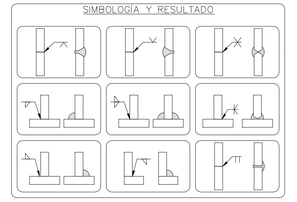


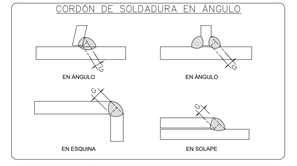
PLACA NE10
UDS.= 24
ESPESOR= 3/4 "

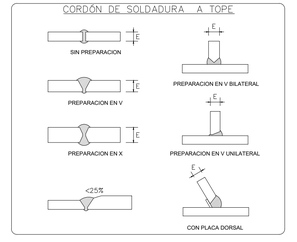


PLACA NE11
UDS.= 16
ESPESOR= 1 1/2 "

NUDO EXTERIOR. DESPICE DE PLACAS
ESCALA 1:20







PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

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PLANOS DE REFERENCIA
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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ADMINISTRADOR UNICO
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DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED. PROF.

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
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APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJO:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (V).

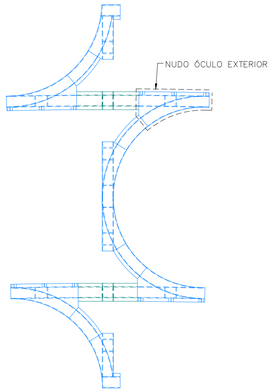
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

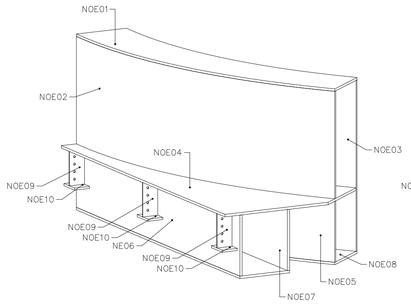
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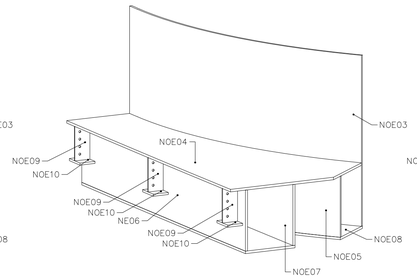
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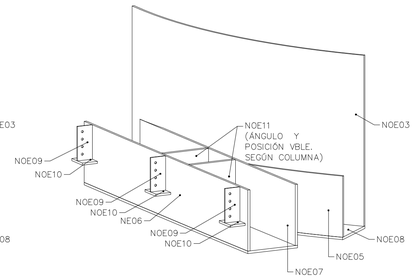
ESCALA	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC:
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ		ACOT. METROS

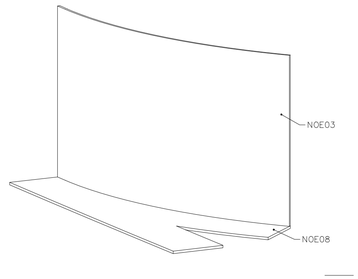
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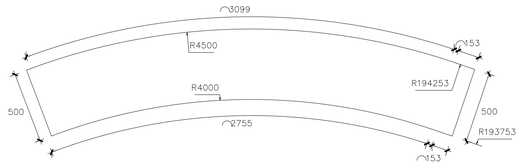




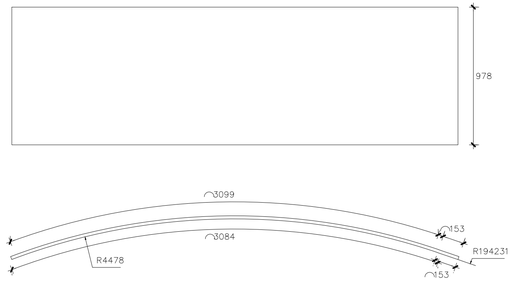
PLACAS COMUNES A TODOS LOS NUDOS

NUDOS INICIO DE ÓCULO. PLANTA
ESCALA 1:125

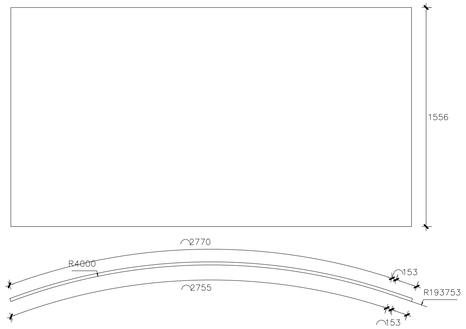
NUDO ÓCULO EXTERIOR. PERSPECTIVAS
SIN ESCALA



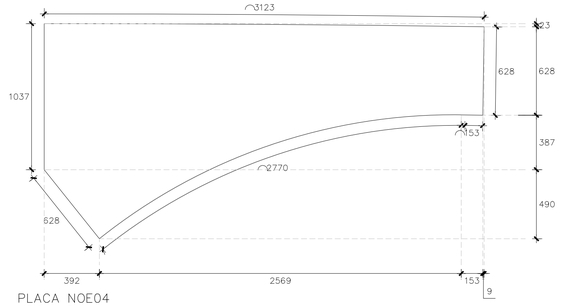
PLACA NOE01
UDS.= 8
ESPESOR= 7/8 "



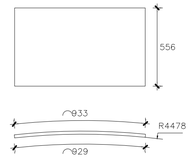
PLACA NOE02
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ESPESOR= 7/8 "



PLACA NOE03
UDS.= 8
ESPESOR= 7/8 "



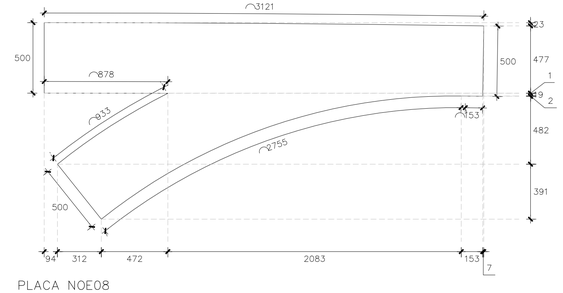
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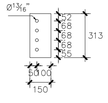
PLACA NOE05
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ESPESOR= 7/8 "



PLACA NOE06
UDS.= 8
ESPESOR= 7/8 "



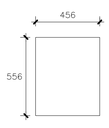
PLACA NOE08
UDS.= 8
ESPESOR= 7/8 "



PLACA NOE09
UDS.= 24
ESPESOR= 3/8 "



PLACA NOE10
UDS.= 24
ESPESOR= 3/4 "

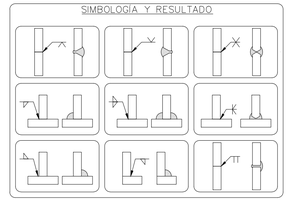


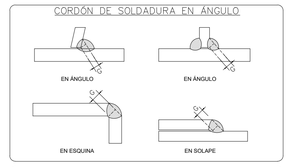
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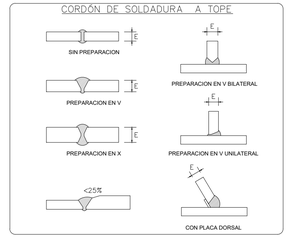


PLACA NOE07
UDS.= 8
ESPESOR= 7/8 "

NUDO ÓCULO EXTERIOR. DESPICE DE PLACAS
ESCALA 1:20







ACERO ESTRUCTURAL

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PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

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ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1456

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0455

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (VI)

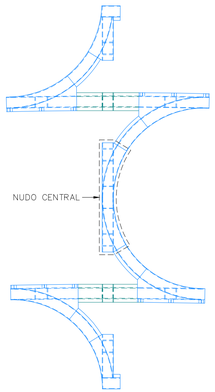
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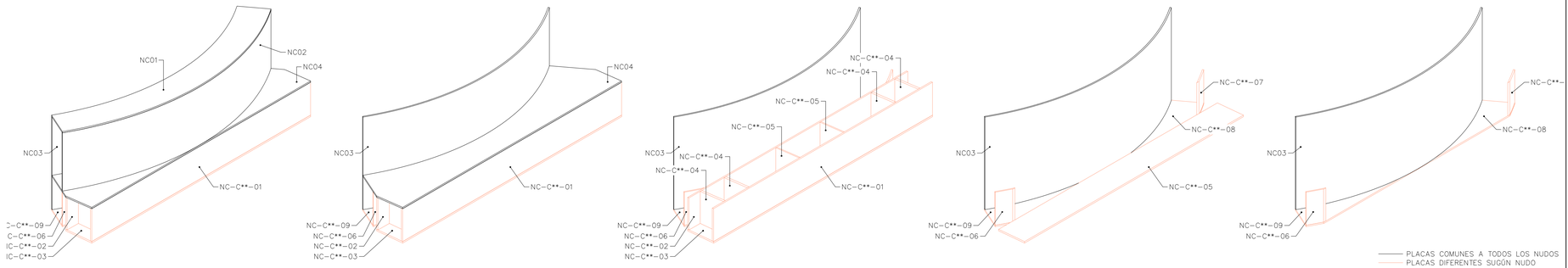
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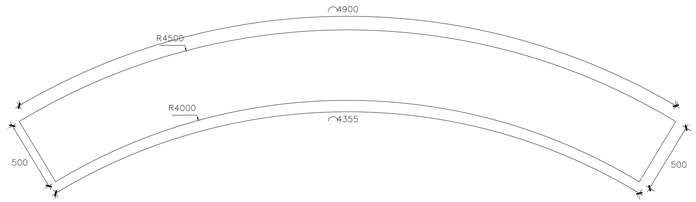
FECHA	DEPTO.	NOMBRE	FIRMA	
	PROYECTO ESTRUCTURA	M.I. INOCENCIO MALDONADO TORRES		MOD. 1:20
	ARQUITECTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		M.C.A. JESÚS IRVING CADENA PÉREZ		ESC:
				ACOT.: METROS

DGOT-20-EST-III-0101-00302-P-00

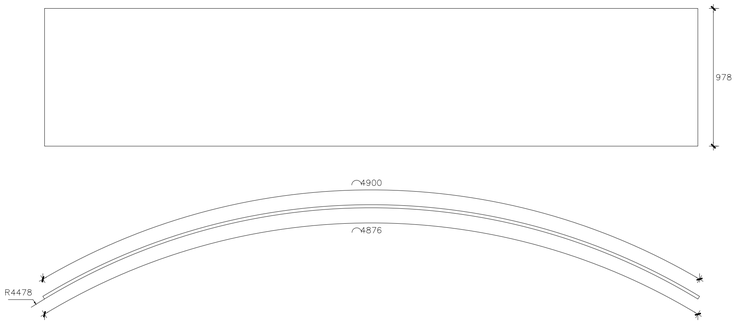




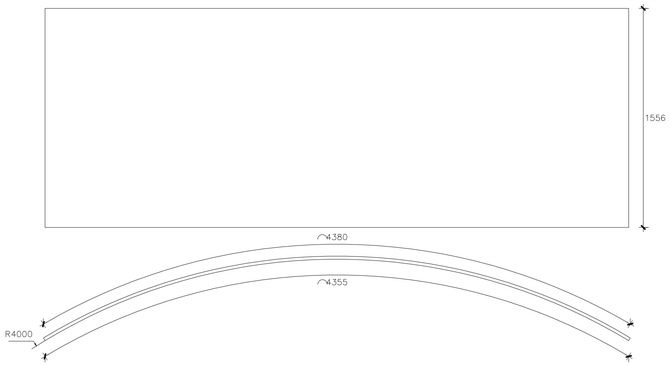
NUDOS INICIO DE ÓCULO. PLANTADO CENTRAL. PERSPECTIVAS
ESCALA 1:125 SIN ESCALA



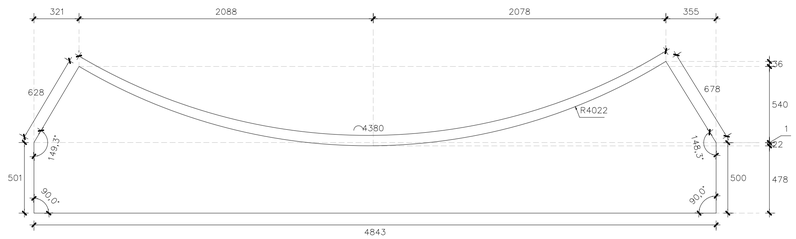
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ESPESOR= 7/8 "



PLACA NC02
UDS.= 8
ESPESOR= 7/8 "



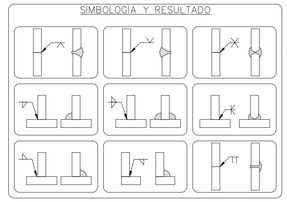
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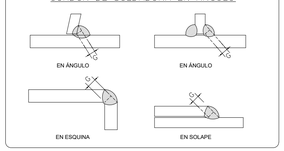
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NUDO CENTRAL. DESPICE DE PLACAS COMUNES
ESCALA 1:20

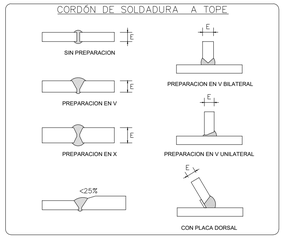
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR UNICO FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID DRO-1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO COE-0265

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (VII)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

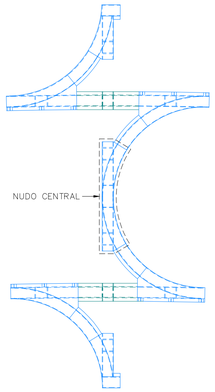
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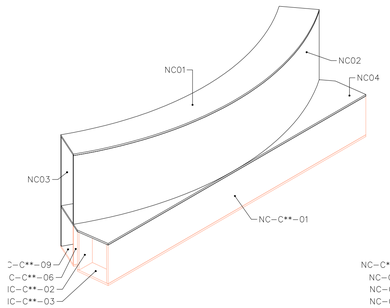
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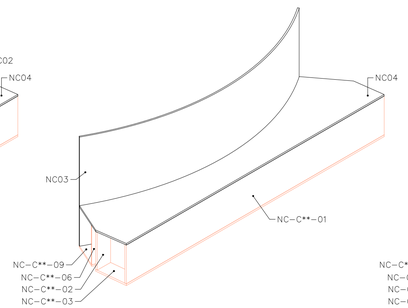
CONTROL	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

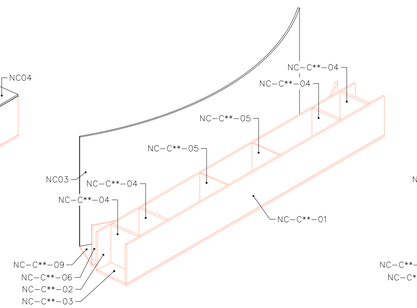
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FECHA: JULIO 2021
ESC.
ACOT. METROS

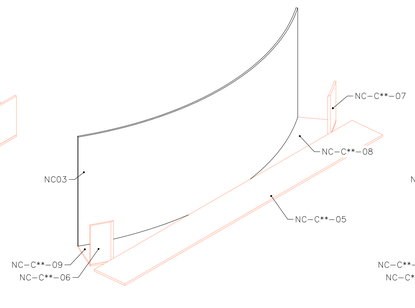
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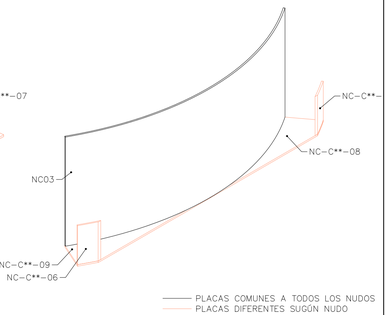






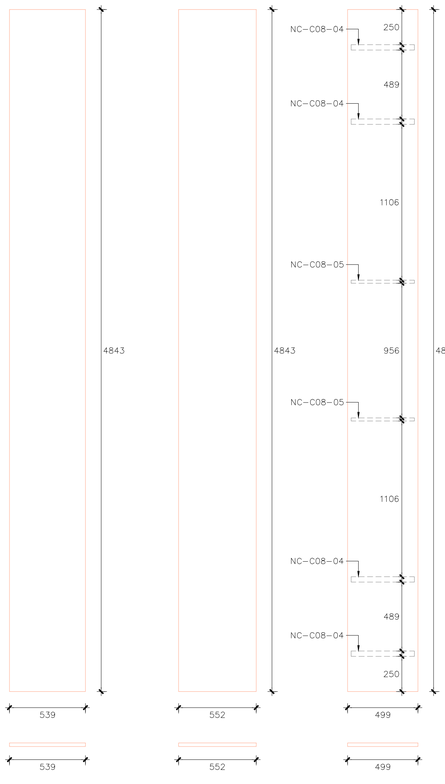






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PLACAS DIFERENTES SUGÚN NUDO

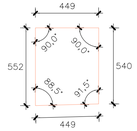
NUDOS INICIO DE ÓCULO. PLANTADO CENTRAL. PERSPECTIVAS
ESCALA 1:125 SIN ESCALA



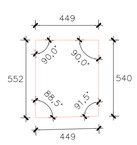
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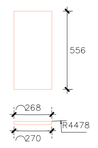
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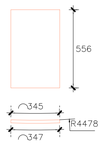
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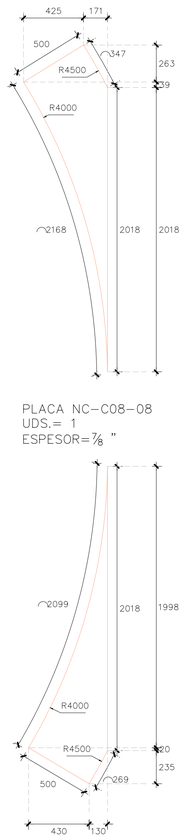
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ESPESOR=⅞ "



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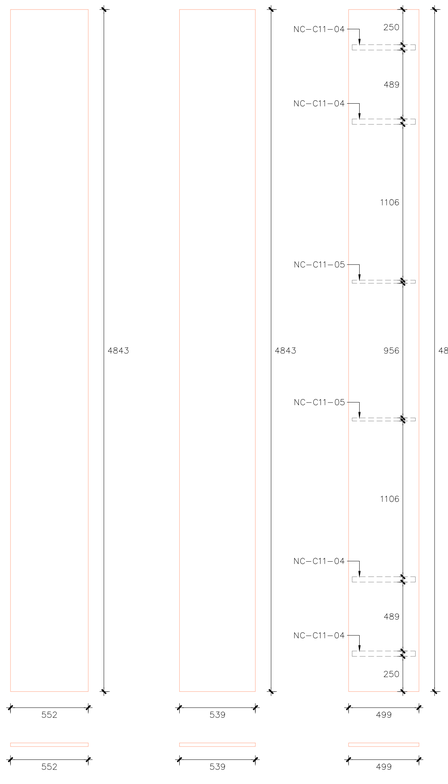


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PLACA NC-C08-08
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ESPESOR=⅞ "

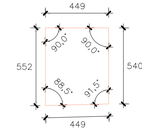
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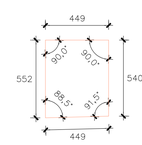
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ESPESOR=1 "

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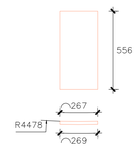
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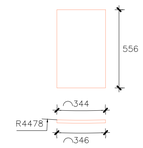
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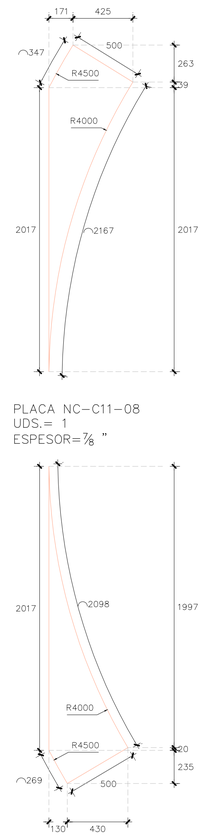
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ESPESOR=⅞ "



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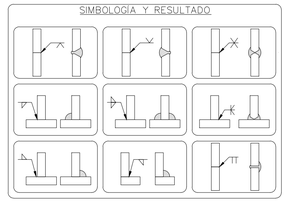
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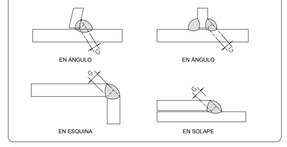
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PLACA NC-C11-09
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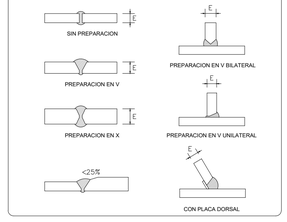
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



NUDO CENTRAL EN COLUMNA C-08

NUDO CENTRAL. DESPICE DE PLACAS VARIABLES
ESCALA 1:20

NUDO CENTRAL EN COLUMNA C-11

ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
	⚠ REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

GOBIERNO DE LA CIUDAD DE MÉXICO

SECRETARIO DE OBRAS Y SERVICIOS
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SUBSECRETARÍA DE INFRAESTRUCTURA

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ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
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DRO-1488

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
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APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (X).

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

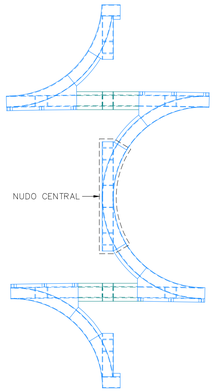
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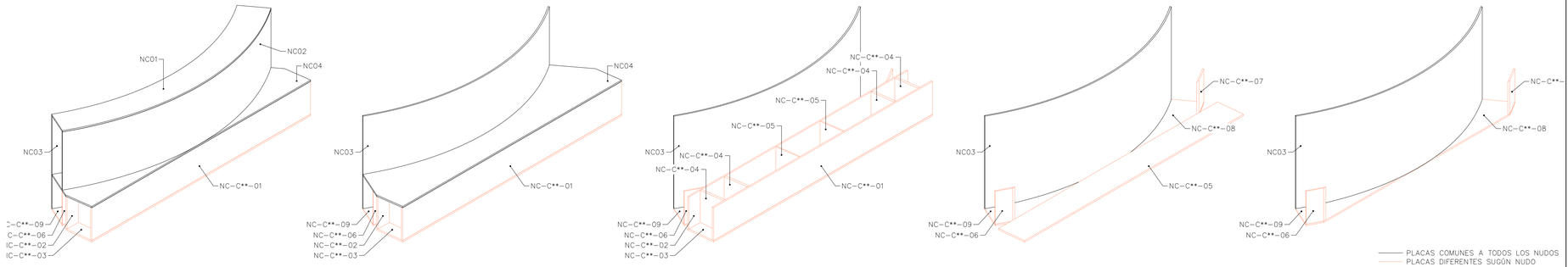
ESCALA GRÁFICA: 0 0.5 1

FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO ESTRUCTURAL	M.I. INOCENCIO MALDONADO TORRES	
	ARQUITECTURA	M.I. ARGEL RAMOS CAPISTRAN	
		M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD. 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

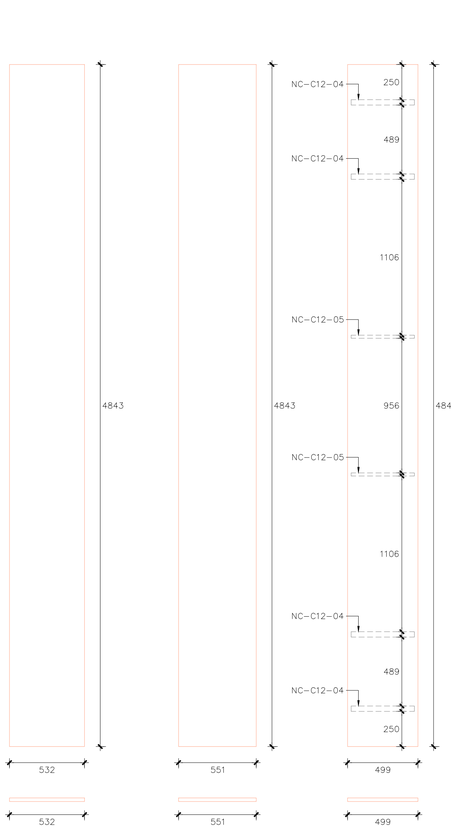
DGOT-20-EST-III-0104-00305-P-00





NUDOS INICIO DE ÓCULO. PLANTADO CENTRAL. PERSPECTIVAS

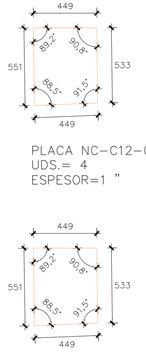
ESCALA 1:125 SIN ESCALA



PLACA NC-C12-01
UDS.= 1
ESPESOR=1 "

PLACA NC-C12-02
UDS.= 1
ESPESOR=1 "

PLACA NC-C12-03
UDS.= 1
ESPESOR=1 "



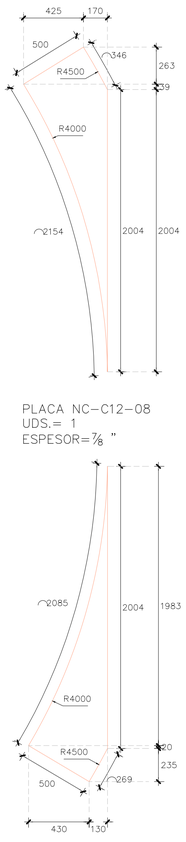
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UDS.= 4
ESPESOR=1 "

PLACA NC-C12-05
UDS.= 2
ESPESOR=7/8 "



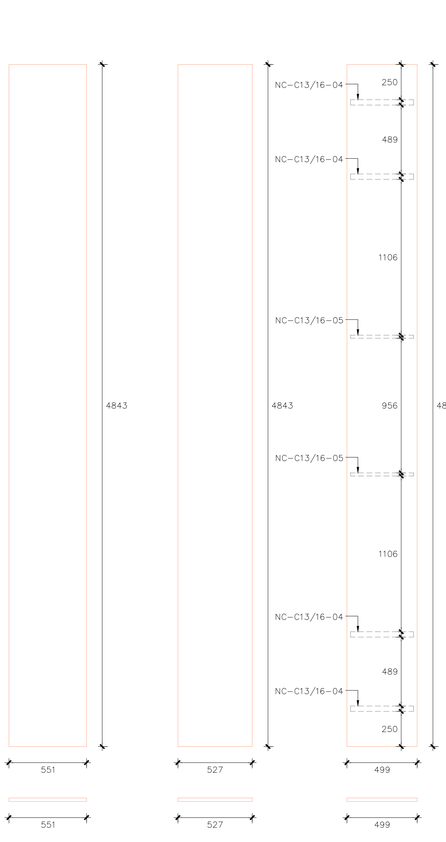
PLACA NC-C12-06
UDS.= 1
ESPESOR=7/8 "

PLACA NC-C12-07
UDS.= 1
ESPESOR=7/8 "



PLACA NC-C12-08
UDS.= 1
ESPESOR=7/8 "

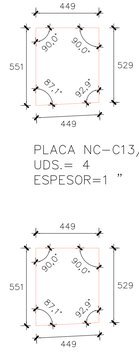
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UDS.= 1
ESPESOR=7/8 "



PLACA NC-C13/16-01
UDS.= 1
ESPESOR=1 "

PLACA NC-C13/16-02
UDS.= 1
ESPESOR=1 "

PLACA NC-C13/16-03
UDS.= 1
ESPESOR=1 "



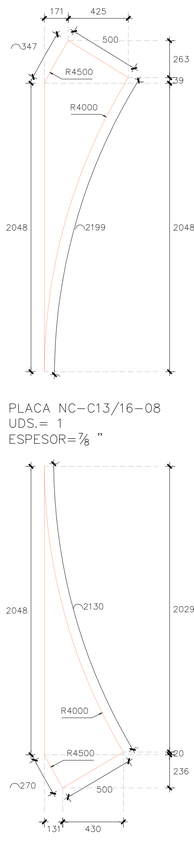
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UDS.= 4
ESPESOR=1 "

PLACA NC-C13/16-05
UDS.= 2
ESPESOR=7/8 "



PLACA NC-C13/16-06
UDS.= 1
ESPESOR=7/8 "

PLACA NC-C13/16-07
UDS.= 1
ESPESOR=7/8 "



PLACA NC-C13/16-08
UDS.= 1
ESPESOR=7/8 "

PLACA NC-C13/16-09
UDS.= 1
ESPESOR=7/8 "

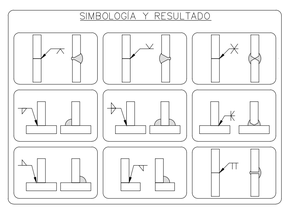
NUDO CENTRAL EN COLUMNA C-12

NUDO CENTRAL EN COLUMNA C-13/16

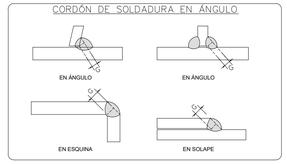
NUDO CENTRAL. DESPICE DE PLACAS VARIABLES

ESCALA 1:20

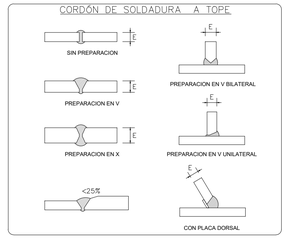
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1498

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
DRO-1498

APROBO: M. I. DANIEL PÉREZ BELLO

REVISO: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO: M.I. EDUARDO DÁVILA ORTEGA

DIBUJO: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (IX).

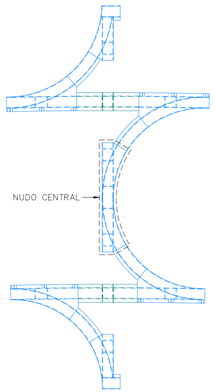
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

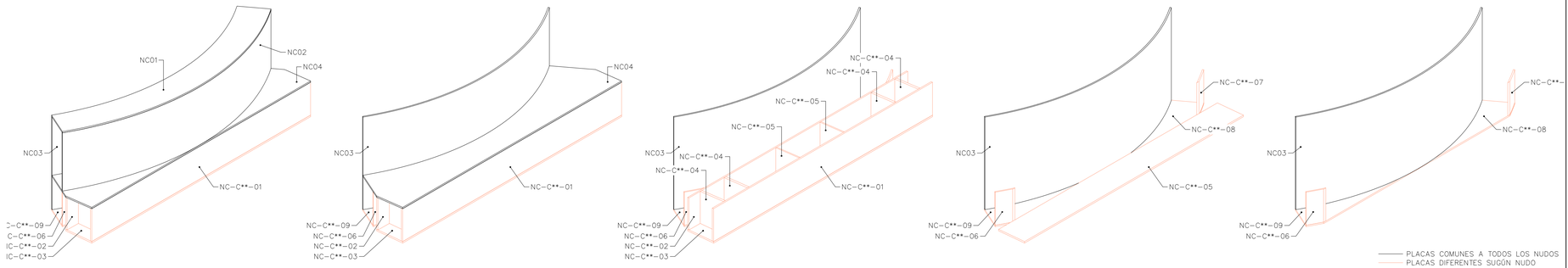
PLANO No.: **DGOT-20-EST-III-0105-00306-P-00**

ESCALA GRÁFICA: 0 2 5 8 1 4

ESCALA	FECHA	DEPTO.	NOMBRE	FIRMA	MOD. 1:20
		PROYECTO	M.I. INCOENCIO MALDONADO TORRES		FECHA: JULIO 2021
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		ESC:
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ACOT: METROS

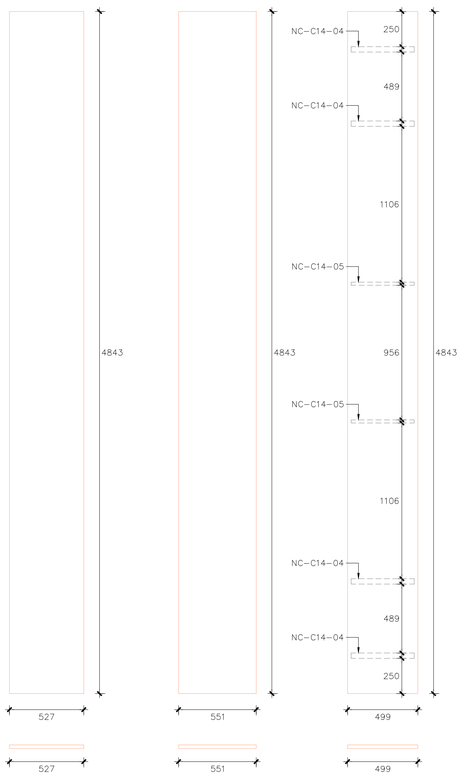
DGOT-20-EST-III-0105-00306-P-00





NUDOS INICIO DE ÓCULO. PLANTA
ESCALA 1:125

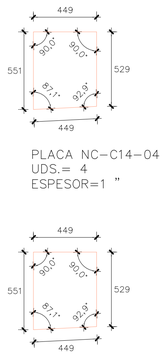
NUDO CENTRAL. PERSPECTIVAS
SIN ESCALA



PLACA NC-C14-01
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ESPESOR=1 "

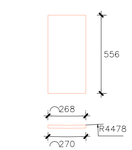
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UDS.= 1
ESPESOR=1 "

PLACA NC-C14-03
UDS.= 1
ESPESOR=1 "

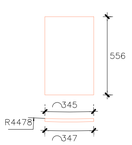


PLACA NC-C14-04
UDS.= 4
ESPESOR=1 "

PLACA NC-C14-05
UDS.= 2
ESPESOR=7/8 "



PLACA NC-C14-06
UDS.= 1
ESPESOR=7/8 "



PLACA NC-C14-07
UDS.= 1
ESPESOR=7/8 "



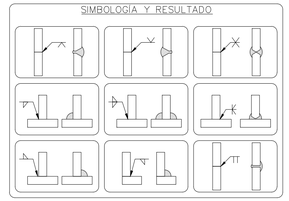
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ESPESOR=7/8 "

PLACA NC-C14-09
UDS.= 1
ESPESOR=7/8 "

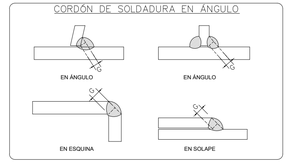
NUDO CENTRAL EN COLUMNA C-14

NUDO CENTRAL. DESPICE DE PLACAS VARIABLES
ESCALA 1:20

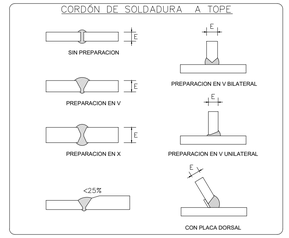
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



ACERO ESTRUCTURAL

- CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN-AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
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ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED.1405

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED.2585

APROBO:
M. I. DANIEL PÉREZ BELLO

REVISO:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTO:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (XII)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

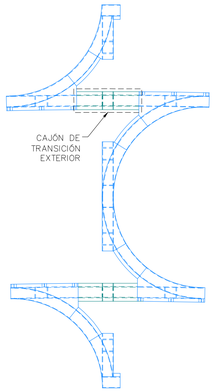
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DGOT-20-EST-III-0106-00307-P-00

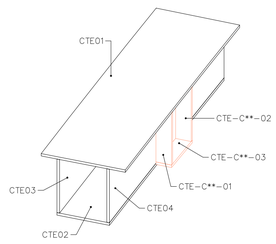
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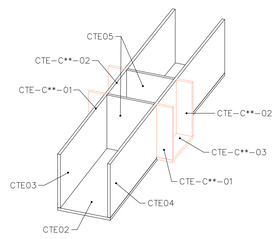
FECHA:	DEPTO.	NOMBRE	FIRMA	MOD: 1:20
	PROYECTO	M.I. INOCENCIO MALDONADO TORRES		
	ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
	ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ		ESC.
				ACOT.: METROS

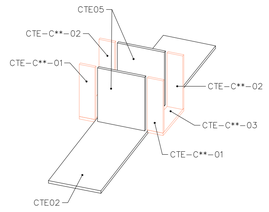
DETALLE

DGOT-20-EST-III-0106-00307-P-00





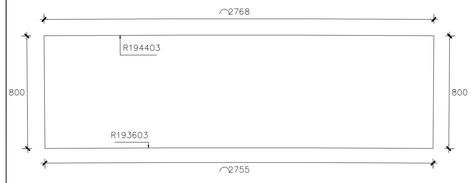




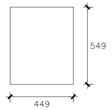
PLACAS COMUNES A TODOS LOS NUDOS
PLACAS DIFERENTES SUGÚN NUDO

NUDOS INICIO DE ÓCULO. PLANTA
ESCALA 1:125

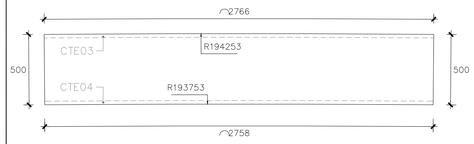
CAJÓN DE TRANSICIÓN EXTERIOR. PERSPECTIVAS
SIN ESCALA



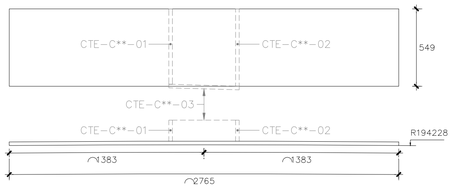
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ESPESOR=1 "



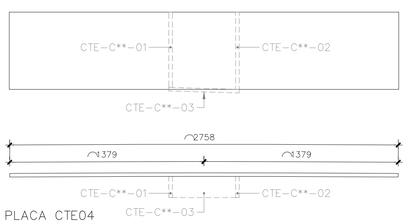
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UDS.= 16
ESPESOR=1 "



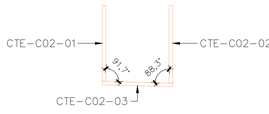
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UDS.= 8
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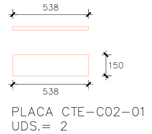
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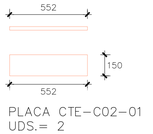
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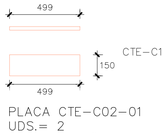
NUDO CENTRAL EN COLUMNA C-02



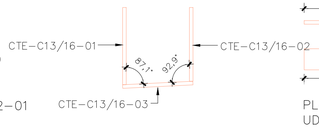
PLACA CTE-C02-01
UDS.= 2
ESPESOR=1 "



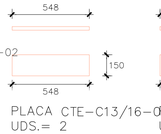
PLACA CTE-C02-01
UDS.= 2
ESPESOR=1 "



PLACA CTE-C02-01
UDS.= 2
ESPESOR=1 "



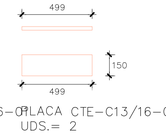
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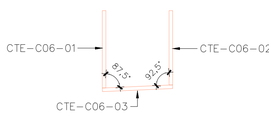
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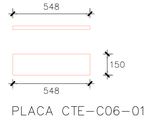
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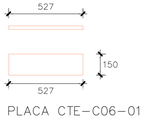
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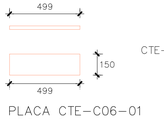
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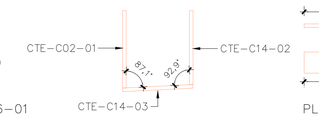
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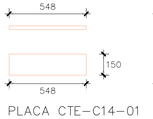
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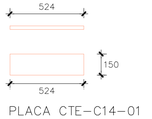
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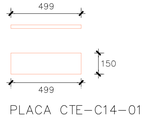
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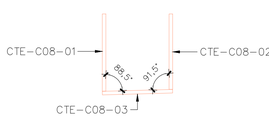
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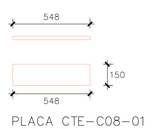
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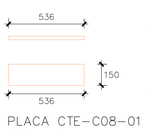
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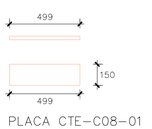
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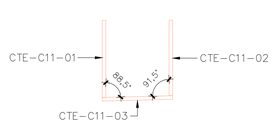
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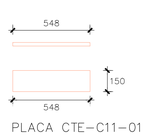
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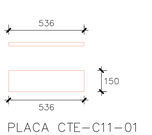
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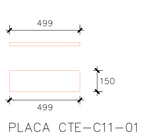
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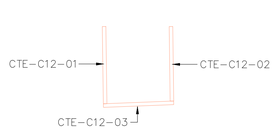
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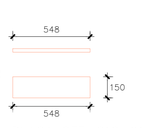
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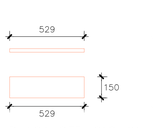
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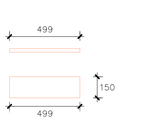
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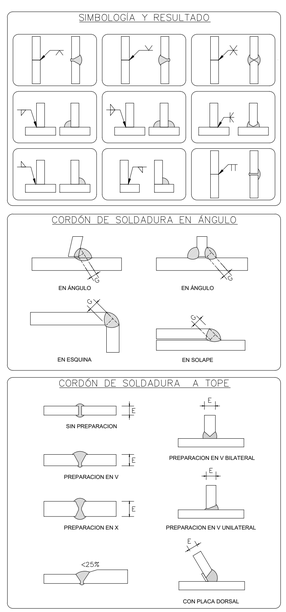
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ESPESOR=1 "



PLACA CTE-C12-01
UDS.= 2
ESPESOR=1 "



PLACA CTE-C12-01
UDS.= 2
ESPESOR=1 "



ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

CAJÓN DE TRANSICIÓN EXTERIOR. DESPICE DE PLACAS COMUNES
ESCALA 1:20

CAJÓN DE TRANSICIÓN EXTERIOR. DESPICE DE PLACAS VARIABLES
ESCALA 1:20

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

PIEDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
PIEDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORresponsal ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0695

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY. 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (XII)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

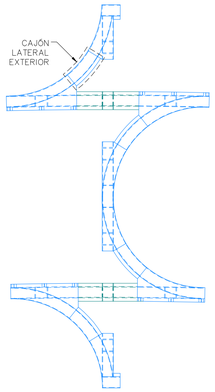
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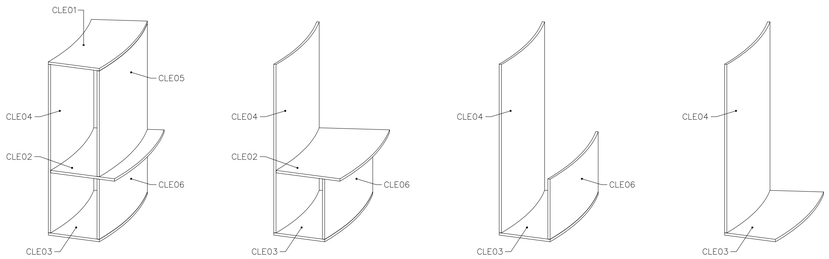
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ESTADO	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:20
FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0107-00308-P-00

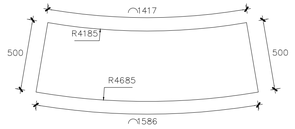




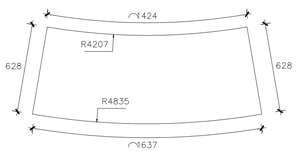
PLACAS COMUNES A TODOS LOS NUDOS

NUDOS INICIO DE ÓCULO. PLANO CAJÓN LATERAL EXTERIOR. PERSPECTIVAS

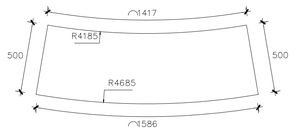
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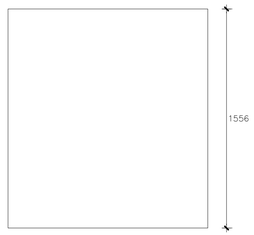
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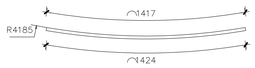


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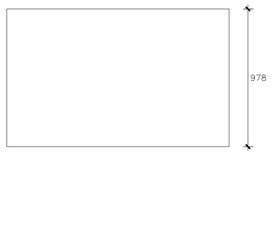


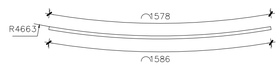
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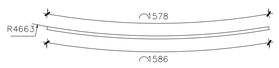
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ESPESOR= 7/8 "





PLACA CLE05
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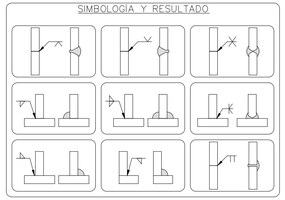


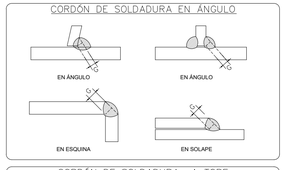


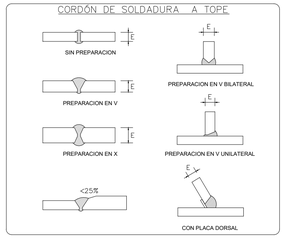
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CAJÓN LATERAL EXTERIOR. DESPICE DE PLACAS

ESCALA 1:20







ACERO ESTRUCTURAL

– CONSULTAR PROPIEDADES Y ESPECIFICACIONES DE LOS MATERIALES, ASÍ COMO ESPECIFICACIONES DE SOLDADURA EN EL PLANO DE NOTAS GENERALES.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FRIDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FRIDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1495

CORRESPONSAL ESTRUCTURAL
ING. LUDO RAMÓN MONTERO OROZCO
COE-0265

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO. ESTRUCTURA METÁLICA
NUDOS EN ZONAS DE ÓCULOS
DEFINICIÓN DE NUDOS (XIII)

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0108-00309-P-00**

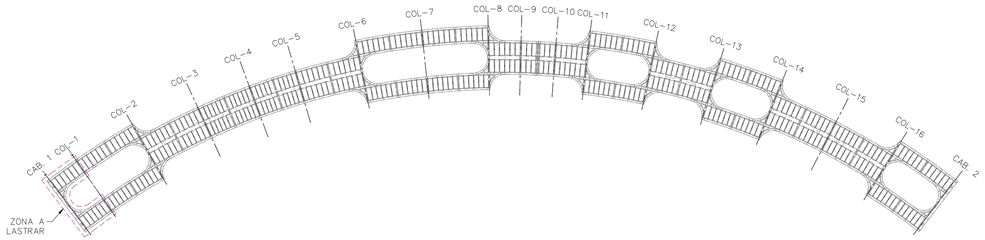
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FECHA	DEPTO.	NOMBRE	FIRMA
	PROYECTO ESTRUCTURA	M.I. INCIENCIO MALDONADO TORRES	
	ARQUITECTURA	M.I. ANGEL RAMOS CAPISTRAN	
		M.C.A. JESÚS IRVING CADENA PEREZ	

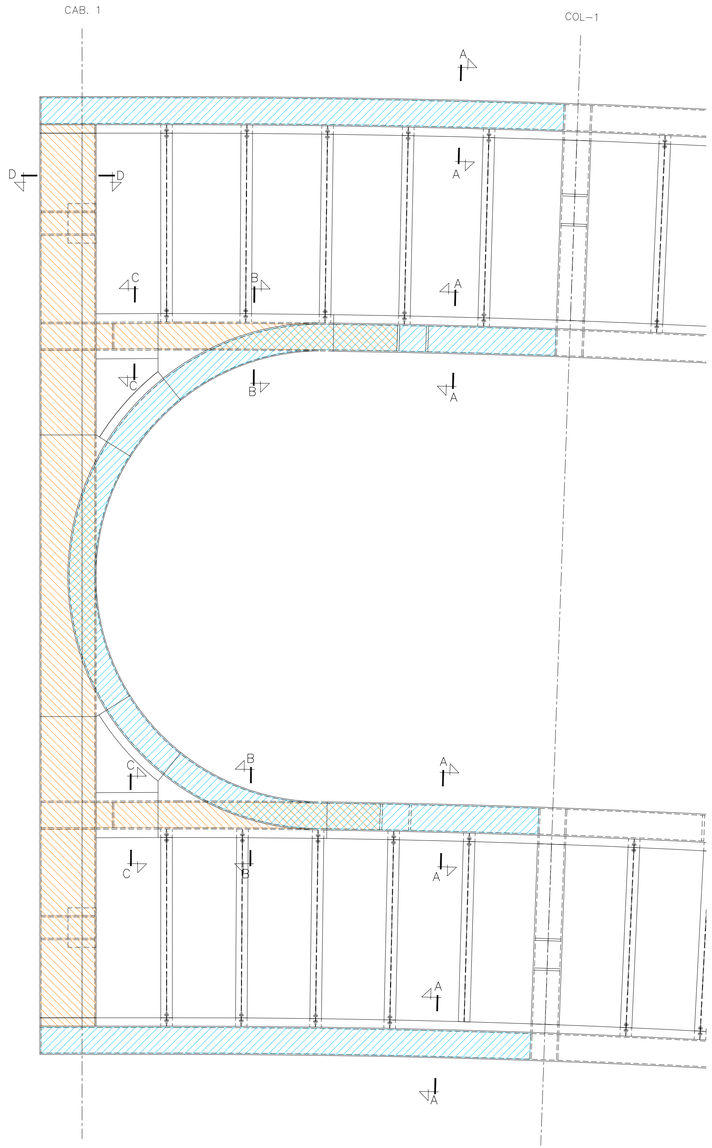
DETALLE

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FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0108-00309-P-00



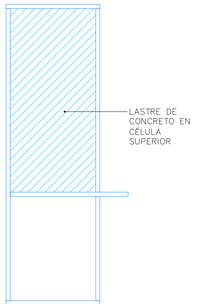
PLANTA GENERAL
ESCALA 1:500



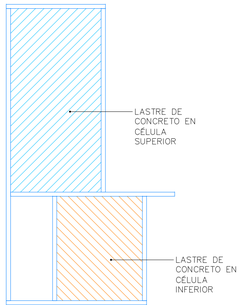
LASTRE EN CLARO 1. PLANLTA
ESCALA 1:50

IMPORTANTE

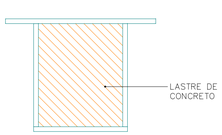
- SE LASTRARÁN LOS PERFILES INDICADOS DEL CLARO 1 MEDIANTE RELLENO DE CONCRETO.
- PREVIAMENTE AL PROCESO DE RELLENO, SE HABRÁ INSTALADO EL TABLERO EN SU POSICIÓN FINAL Y SE HABRÁN REALIZADO PARA LA ESTRUCTURA METÁLICA TODAS LAS CONEXIONES DE OBRA QUE RESULTEN NECESARIAS SEGÚN EL PROCESO CONSTRUCTIVO.
- LAS PLACAS SUPERIORES DE LOS PERFILES A LASTRAR ESTARÁN PROVISTAS DE VENTANAS QUE POSIBILITEN EL COLADO DEL CONCRETO. ESTAS VENTANAS SE CERRARÁN MEDIANTE SOLDADURA UNA VEZ SE HAYA PRODUCIDO EL FRAGUADO.
- SE CONTROLARÁ EL VOLUMEN DE CONCRETO INTRODUCIDO A FIN DE GARANTIZAR LA EJECUCIÓN DEL PESO TOTAL DEL LASTRE.



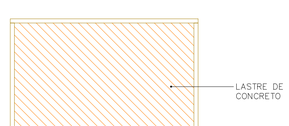
SECCIÓN A–A
ESCALA 1:15



SECCIÓN B–B
ESCALA 1:15

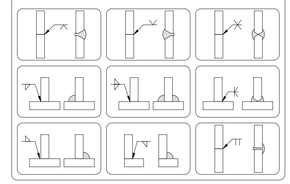


SECCIÓN C–C
ESCALA 1:15

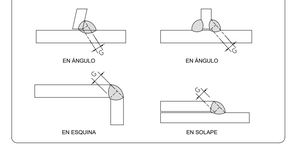


SECCIÓN D–D
ESCALA 1:15

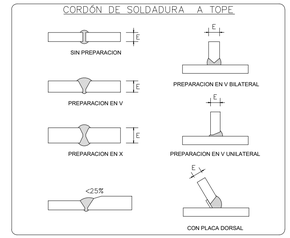
SIMBOLOGÍA Y RESULTADO



CORDÓN DE SOLDADURA EN ÁNGULO



CORDÓN DE SOLDADURA A TOPE



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

FREDEL ING. Y ARQ. S.A. DE C.V.

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CPD-1481

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CPD-1995

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO
LASTRE EN CLARO 1

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

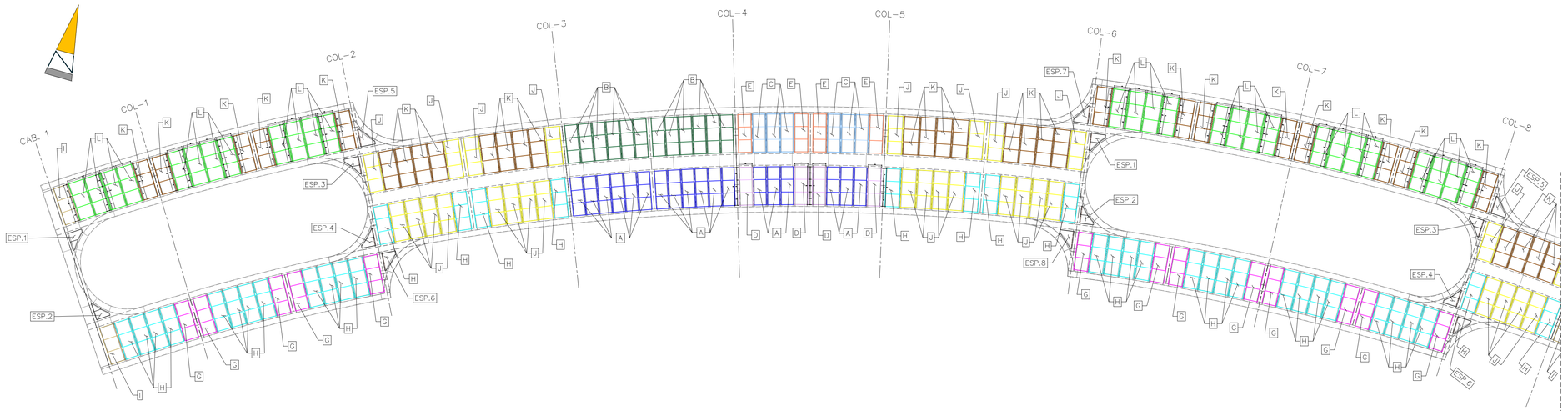
PLANO No.
DGOT-20-EST-III-0109-00310-P-00

ESCALA GRAFICA
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REVISÓ	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INOCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CARPETNAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

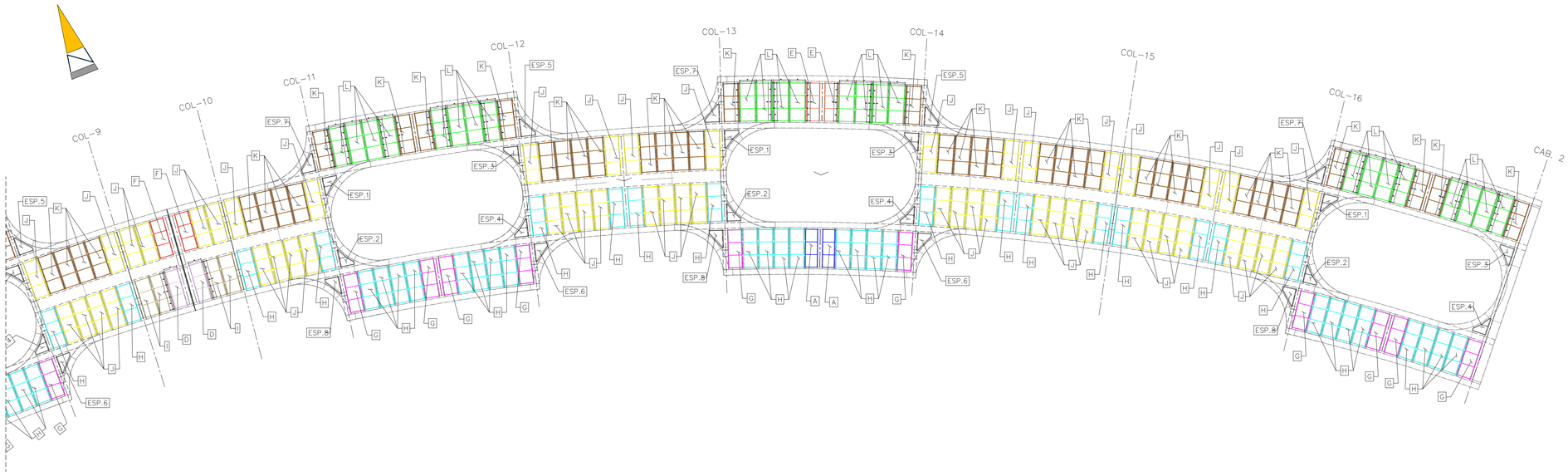
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ESC.
ACOT.: METROS

DGOT-20-EST-III-0109-00310-P-00



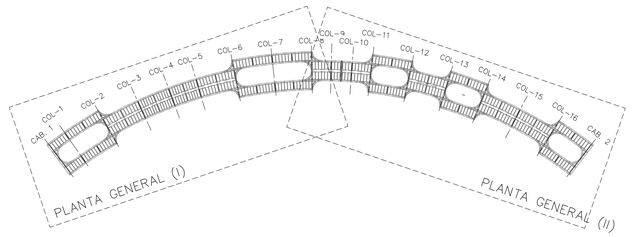
TABLETAS PREFABRICADAS. PLANTA GENERAL (I)

ESCALA 1:200



TABLETAS PREFABRICADAS. PLANTA GENERAL (II)

ESCALA 1:200



PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
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PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1400

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CISE-0083

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

TABLERO
TABLETAS PREFABRICADAS
PLANTA GENERAL

TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

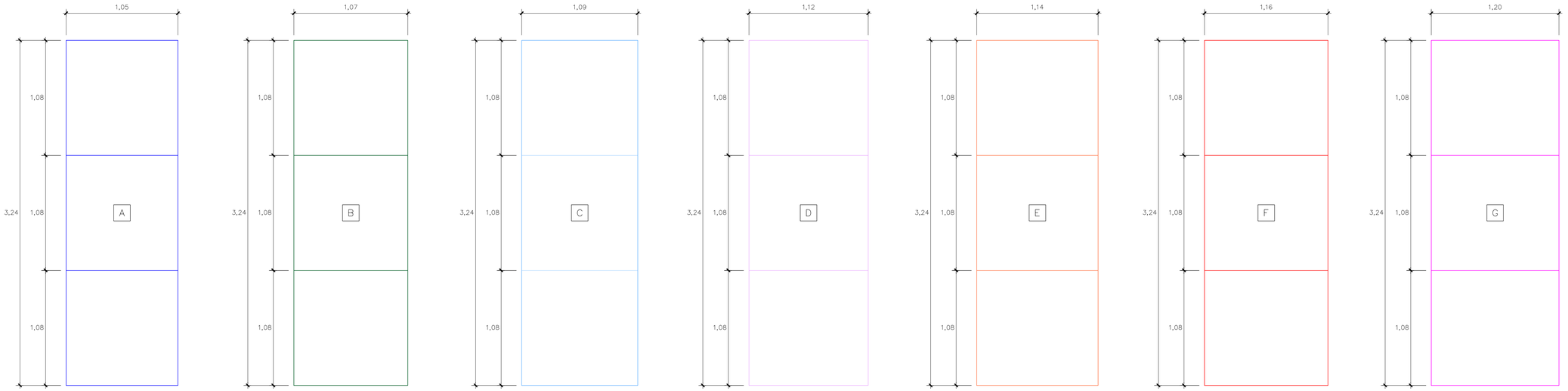
PLANO No.: **DGOT-20-EST-III-0110-00311-P-00**

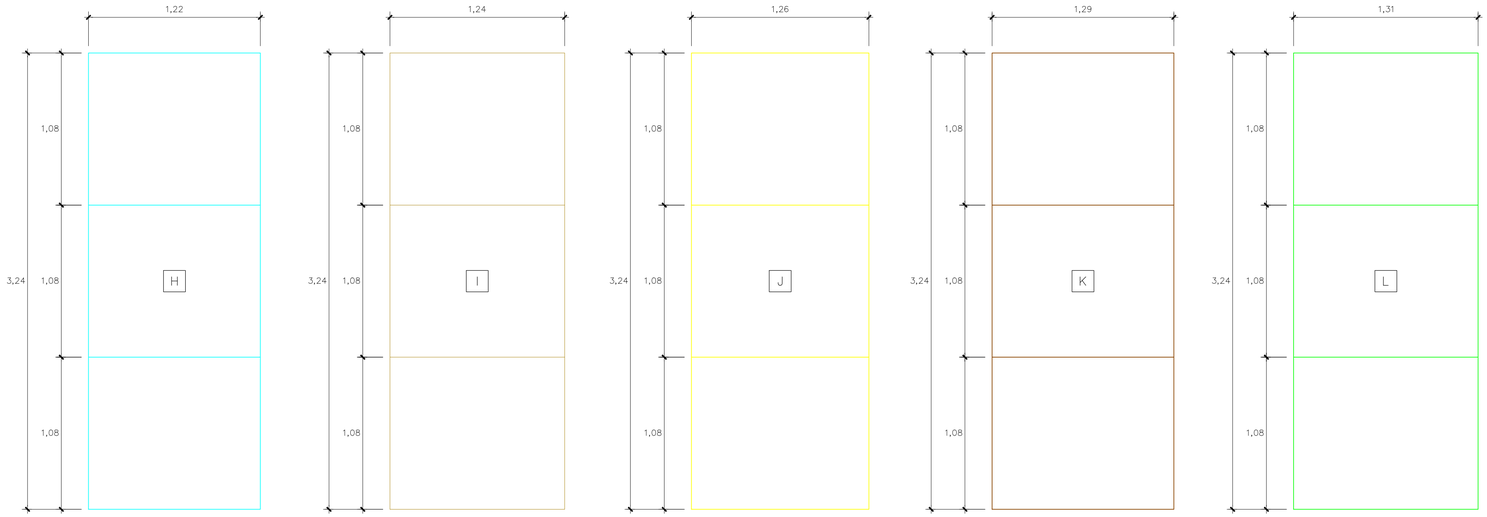
ESCALA GRÁFICA: 0 4 8 12 20

CONTROL	FECHA	DEPTO	NOMBRE	FIRMA
		PROYECTO	M.I. ROGENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PEREZ	

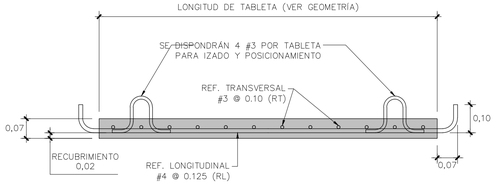
MOD. 1:200
FECHA: JULIO 2021
ESC.
ACOT. METROS

DGOT-20-EST-III-0110-00311-P-00

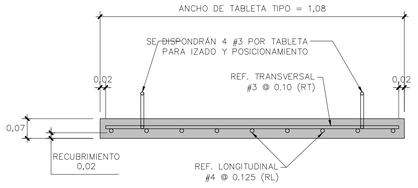




TABLETAS PREFABRICADAS TIPO
GEOMETRÍA
ESCALA 1:20



SECCIÓN SEGÚN DIRECCIÓN LONGITUDINAL DE ESTRUCTURA



SECCIÓN SEGÚN DIRECCIÓN TRANSVERSAL DE ESTRUCTURA

TABLETAS PREFABRICADAS TIPO
REFUERZO
ESCALA 1:10



NOTAS TABLETAS PREFABRICADAS

1. LAS TABLETAS SON COLABORANTES CON LA LOSA IN SITU.
2. LA SUPERFICIE SUPERIOR DE LA TABLETA DEBERÁ QUEDAR CON CORRUGACIONES DE AL MENOS 6.35 mm.
3. REFUERZO:
   EN SU DIRECCIÓN LONGITUDINAL, LAS TABLETAS TENDRÁN UN APOYO SOBRE LA ESTRUCTURA METÁLICA DE TABLERO DE 5 cm.

   EN SU DIRECCIÓN TRANSVERSAL, LAS TABLETAS TENDRÁN UN APOYO SOBRE LA ESTRUCTURA METÁLICA DE TABLERO DE 2 cm.

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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PLANOS DE REFERENCIA
DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE
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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

PREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
PREDEL INGENIERÍA Y ARQUITECTURA S.A.DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO 1490

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CRE 0999

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020
PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
TABLERO
TABLETAS PREFABRICADAS
GEOMETRÍA Y REFUERZO (I)

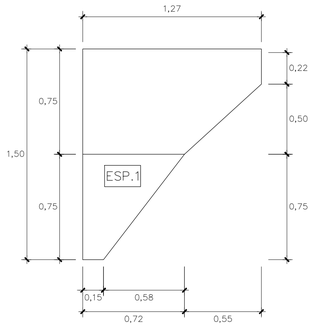
TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

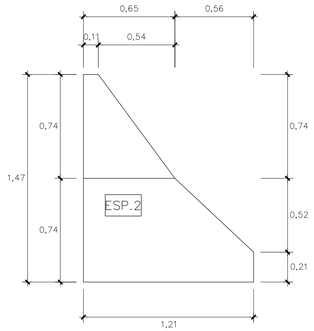
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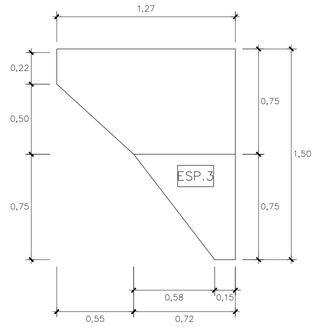
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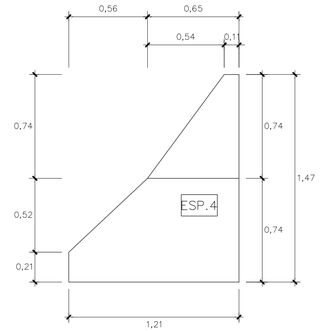
	FECHA	DEPTO.	NOMBRE	FIRMA	
CEDULA		PROYECTO	ING. INOCENCIO MALDONADO TORRES		MOD. 1:20
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ		ESC.
					ACOT. METROS

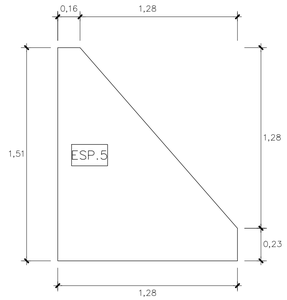
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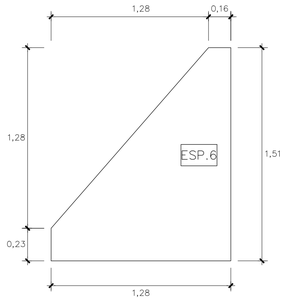


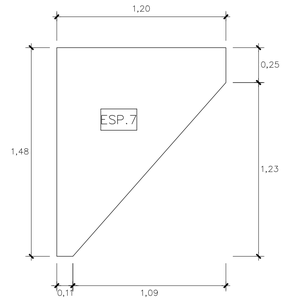


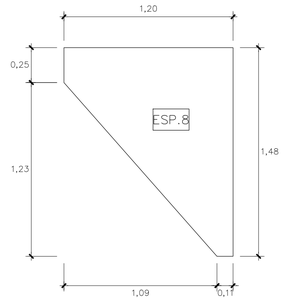




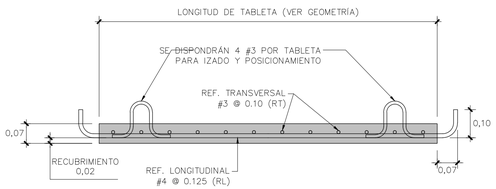




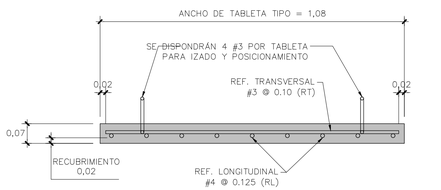




TABLETAS PREFABRICADAS ESPECIALES
GEOMETRÍA
ESCALA 1:20



SECCIÓN SEGÚN DIRECCIÓN LONGITUDINAL DE ESTRUCTURA



SECCIÓN SEGÚN DIRECCIÓN TRANSVERSAL DE ESTRUCTU

TABLETAS PREFABRICADAS ESPECIALES
REFUERZO
ESCALA 1:10



NOTAS TABLETAS PREFABRICADAS

1. LAS TABLETAS SON COLABORANTES CON LA LOSA IN SITU.
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PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

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3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

ESTE PLANO SE COMPLEMENTA CON TODOS LOS PLANOS, DOCUMENTOS, ESPECIFICACIONES Y MEMORIAS DE TODAS LAS DISCIPLINAS DEL PROYECTO, LOS CUALES DEBERÁN SER REVISADOS POR EL LICITANTE Y/O CONSTRUCTOR, ANTES DE INICIAR LA CONSTRUCCIÓN.

No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

FREDEL ING. Y ARQ. S.A. DE C.V.

DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
FREDEL INGENIERÍA Y ARQUITECTURA S.A DE C.V
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1485

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CRE-0485

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TITULO DEL PLANO:

TABLERO
TABLETAS PREFABRICADAS
GEOMETRÍA Y REFUERZO (II)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN -
AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

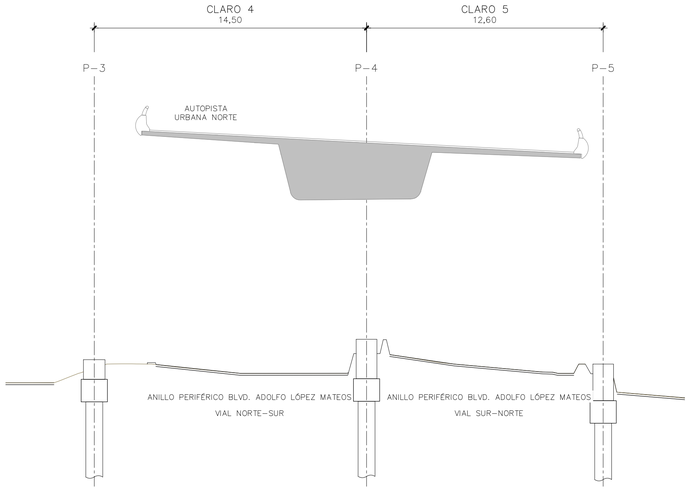
PLANO No.
DGOT-20-EST-III-0112-00313-P-00

ESCALA GRÁFICA
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CEDULA	FECHA	DEPTO.	NOMBRE	FIRMA
		PROYECTO	M.I. INCENCIO MALDONADO TORRES	
		ESTRUCTURA	M.I. ANGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PEREZ	

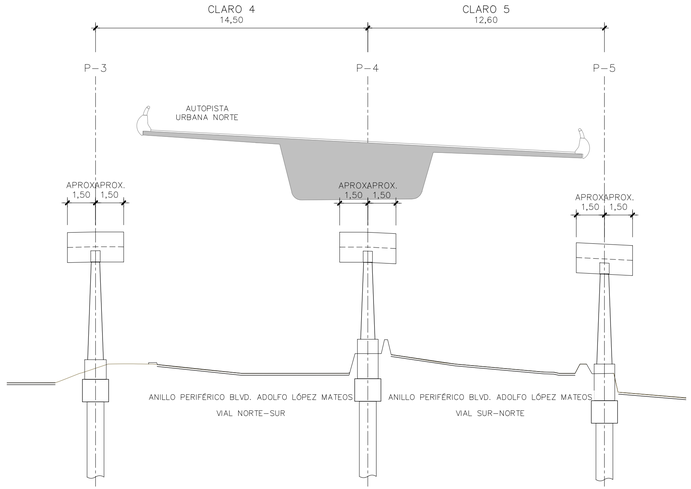
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FECHA: JULIO 2021
ESC:
ACOT: METROS

DGOT-20-EST-III-0112-00313-P-00



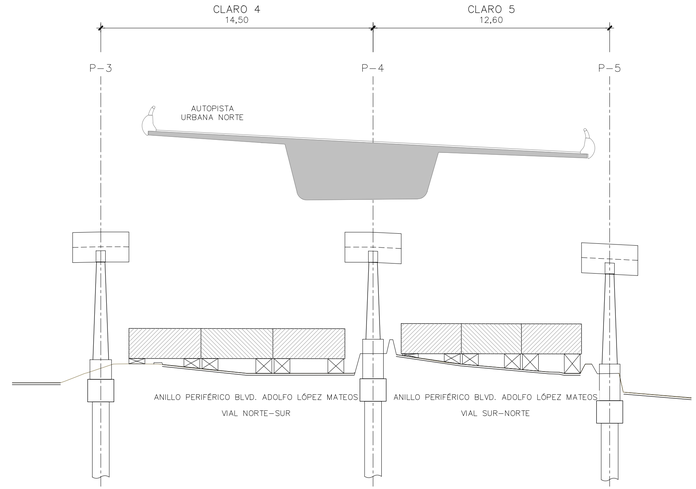
FASE 1:

- REPLANTEO EN PLANTA DE LA ESTRUCTURA.
- MOVIMIENTO DE TIERRAS Y EJECUCIÓN DE CIMENTACIONES (PILAS, ENCEPADOS Y PLINTOS DE CONCRETO)



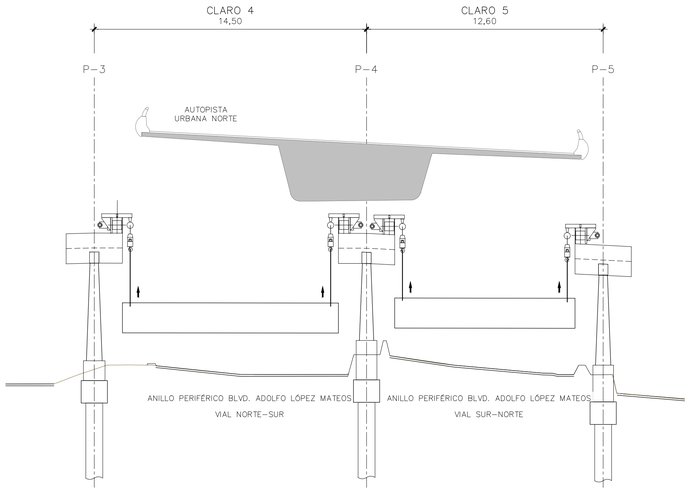
FASE 2:

- LAS COLUMNAS Y UNA FRACCIÓN DE ESTRUCTURA DE TABLERO QUE VA SOBRE ELLAS DEBEN SER TRASLADADAS POR PIEZAS A LA ZONA DE OBRA Y SER SOLDADAS ALLÍ EN EL TALLER DE OBRA.
- UNA VEZ SOLDADAS SE POSICIONAN EN SU UBICACIÓN DEFINITIVA.



FASE 3:

- EL TRAMO DE TABLERO INTERMEDIO SE TRASLADA A LA OBRA DIVIDIDO EN 3 SUBTRAMOS, QUE DEBEN COLOCARSE EN SU POSICIÓN EN PLANTA, PERO NO EN ALZADO; ES DECIR, SE COLOCAN SOBRE EL VIAL DEL PERIFÉRICO CORRESPONDIENTE. (DEBEN PREVERSE BASES PARA COLOCAR LOS TRAMOS METÁLICOS PARA EVITAR ESTROPEAR LAS CHAPAS)
- MEDIANTE TRÁCTELES SE APROXIMAN LOS TRAMOS ENTRE SÍ PARA PARA PERMITIR QUE PUEDAN SER SOLDADOS A NIVEL DE SUELO.



FASE 4:

- UNA VEZ LOS TRAMOS INTERMEDIOS SE HAN SOLDADO SE PROCEDERÁ A SU IZADO HASTA SU POSICIÓN DEFINITIVA MEDIANTE SISTEMA DE POLEAS Y TRÁCTELES.
- UNIÓN DE LOS TRAMOS INTERMEDIOS A LOS TRAMOS SOBRE COLUMNAS MEDIANTE SOLDADURA

OBSERVACIONES GENERALES

- AUNQUE EN LAS FIGURAS SE REPRESENTA LA EJECUCIÓN DE FASES PARA LOS CLAROS 4 Y 5 DE FORMA SIMULTÁNEA, POR MOTIVOS DE MANTENIMIENTO DEL TRÁFICO, DEBERÁN REALIZARSE EN PRIMER LUGAR LAS FASES PARA UNO DE LOS CLAROS Y POSTERIORMENTE REPETIRLAS PARA EL OTRO.
- DURANTE EL TRANSCURSO DE LOS TRABAJOS PARA LA CONSTRUCCIÓN DE CADA CLARO EL TRÁFICO DEL VIAL CORRESPONDIENTE DEBERÁ PERMANECER CERRADO.
- SE ESTIMA QUE LA ELABORACIÓN DE LAS FASES DE EJECUCIÓN PARA CADA CLARO TENGA UNA DURACIÓN DE DOS DÍAS.

PROCESO CONSTRUCTIVO DE CLAROS BAJO VIADUCTO DE AUTOPISTA URBANA

ESCALA 1:150

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

1. LAS COORDENADAS REPRESENTADAS SE ENCUENTRAN EN EL SISTEMA UNIVERSAL TRANSVERSE MERCATOR (UTM).
2. COORDENADAS Y NIVELES EN METROS
3. DIMENSIONES EN METROS EXCEPTO INDICADAS
4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
1	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

JEFA DE GOBIERNO DE LA CIUDAD DE MÉXICO
DRA. CLAUDIA SHEINBAUM PARDO

SECRETARIO DE OBRAS Y SERVICIOS
MTRO. JESÚS ANTONIO ESTEVA MEDINA

SUBSECRETARÍA DE INFRAESTRUCTURA

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DIRECTOR GENERAL DE OBRAS PARA EL TRANSPORTE
ING. HUGO FLORES SÁNCHEZ

ADMINISTRADOR ÚNICO
PRODEL INGENIERÍA Y ARQUITECTURA S.A.DE C.V.
ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
CED 1985

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CED 1985

APROBÓ: M. I. DANIEL PÉREZ BELLO

REVISÓ: M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ: M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ: M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:

PROCESO CONSTRUCTIVO (TIPO 1)

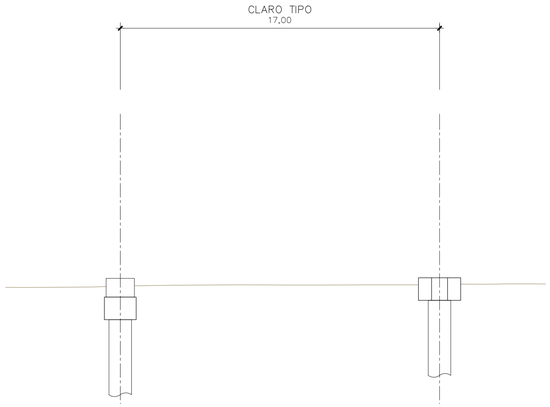
TRAMO / ESTACIÓN: AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.: **DGOT-20-EST-III-0114-00315-P-00**

ESCALA GRÁFICA: 0 5 10 15

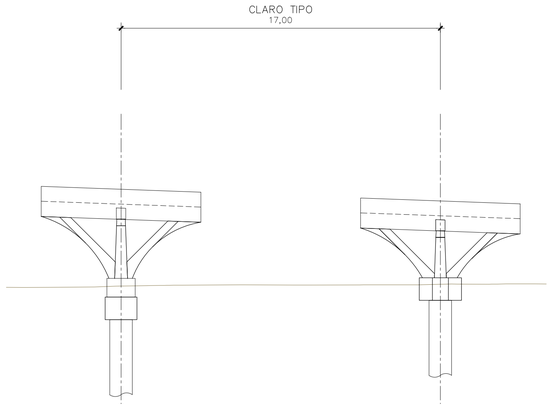
CICLO	FECHA	DEPTO.	NOMBRE	FIRMA	
		PROYECTO	ING. INOCENCIO MALDONADO TORRES		MOD. 1:150
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN		FECHA: JULIO 2021
		ARQUITECTURA	M.C.A. JESUS IRVING CADENA PÉREZ		ESC:
					ACOT: METROS

DGOT-20-EST-III-0114-00315-P-00



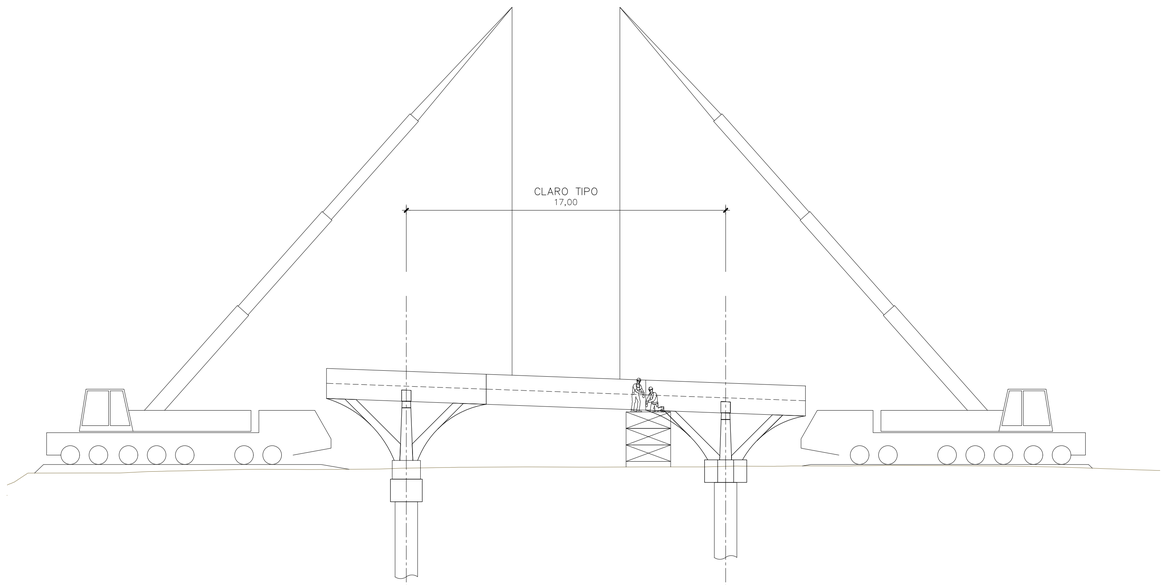
FASE 1:

- REPLANTEO EN PLANTA DE LA ESTRUCTURA.
- MOVIMIENTO DE TIERRAS Y EJECUCIÓN DE CIMENTACIONES (PILAS, ENCEPADOS Y PLINTOS DE CONCRETO)



FASE 2:

- LAS COLUMNAS Y UNA FRACCIÓN DE ESTRUCTURA DE TABLERO QUE VA SOBRE ELLAS DEBEN SER TRASLADADAS POR PIEZAS A LA ZONA DE OBRA Y SER SOLDADAS ALLÍ EN EL TALLER DE OBRA.
- UNA VEZ SOLDADAS SE POSICIONAN EN SU UBICACIÓN DEFINITIVA.



FASE 3:

- EL TRAMO DE TABLERO INTERMEDIO SE TRASLADA A LA OBRA DIVIDIDO EN 3 SUBTRAMOS
- LOS SUBTRAMOS SE COLOCAN EN SU POSICIÓN DEFINITIVA MEDIANTE GRÚAS, EN DONDE SE PROCEDERÁ A SU UNIÓN CON LOS TRAMOS YA COLOCADOS MEDIANTE SOLDADURA.

PROCESO CONSTRUCTIVO DE CLAROS TIPO FUERA DEL ÁMBITO DEL VIADUCTO DE AUTOPISTA URBANA

ESCALA 1:150

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN–AV. COMPOSITORES, 2A. SECC. DEL BOSQUE DE CHAPULTEPEC

CROQUIS DE LOCALIZACIÓN



CROQUIS DE TRAMO



SIMBOLOGÍA

NOTAS GENERALES

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4. LAS COTAS RIGEN AL PLANO
5. SE DEBERÁ GARANTIZAR UN GÁLIBO VERTICAL MÍNIMO DE 5.50m DESDE LA PARTE BAJA DE LA ESTRUCTURA HASTA EL PAVIMENTO DE LAS VIALIDADES

PLANOS DE REFERENCIA

DGOT-20-EST-III-0004-00205-P-00 @ DGOT-20-EST-III-0115-00316-P-00

NOTA IMPORTANTE

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No.	MODIFICACIÓN	FECHA	APROBÓ	Vo. Bo.
	ENTREGA PARA REVISIÓN			
⚠	REVISIÓN GENERAL PARA CONSTRUCCIÓN	JUL/21		

GOBIERNO DE LA CIUDAD DE MÉXICO

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ING. DAVID S. QUINTERO CAMPOS

DIRECTOR RESPONSABLE DE OBRA
ING. ARQ. EDMUNDO REYES MADRID
DRO-1455

CORRESPONSAL ESTRUCTURAL
ING. LUCIO RAMÓN MONTERO OROZCO
CSE-0945

APROBÓ:
M. I. DANIEL PÉREZ BELLO

REVISÓ:
M.V.T. GERMÁN GARCÍA DEHEZA

PROYECTÓ:
M.I. EDUARDO DÁVILA ORTEGA

DIBUJÓ:
M.B.

OBSERVACIONES:

CONTRATO No. DGOT-IR-F-4-004-2020

PROYECTO INTEGRAL DE LA CALZADA FLOTANTE LOS PINOS PARA LA CONEXIÓN PEATONAL DE MOLINO DEL REY, 1A. SECCIÓN -AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

TÍTULO DEL PLANO:
PROCESO CONSTRUCTIVO (TIPO 2)

TRAMO / ESTACIÓN:
AV. MOLINO DEL REY 1A. SECCIÓN - AV. COMPOSITORES 2A. SECC. DEL BOSQUE DE CHAPULTEPEC.

PLANO No.:
DGOT-20-EST-III-0115-00316-P-00

ESCALA GRÁFICA: 0 1 2 3 4 5

	FECHA	DEPTO.	NOMBRE	FIRMA
CROQUIS		PROYECTO	M.I. RODRIGO MALDONADO TORRES	
		ESTRUCTURA	M.I. ARGEL RAMOS CAPISTRAN	
		ARQUITECTURA	M.C.A. JESÚS IRVING CADENA PÉREZ	

MOD: 1:100
FECHA: JULIO 2021
ESC:
ACOT.: METROS

DGOT-20-EST-III-0115-00316-P-00